CUES AND STRATEGIES ASSOCIATED WITH THE ELIMINATION OF ADULT AGE DIFFERENCES IN THE RECALL OF SUBJECT PERFORMED TASKS

By

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Margaret P. Norris

Dedicated, in memory,

to my father

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Abstract of Dissertation Presented to the Graduate School of
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The aging effect which has been observed in traditional verbal recall tasks has recently been examined in activity recall, a new paradigm for everyday memory research. In contrast to verbal recall tasks, age differences in Subject Performed Tasks (SPTs) are not consistently observed. Three experiments explored variables which may influence the absence of adult age differences in SPT recall. The multimodal hypothesis suggests that older adults perform as well as the young in SPT recall because older adults benefit from the presence of motor and object cues. Partial support for this hypothesis was found in Experiments 1 and 2. Although young adults recalled more than older adults when actions were enacted during encoding (motor encoding), age differences in recall were eliminated in the motor retrieval conditions. The presence of object during encoding did not influence age differences in recall; however, object presence interacted with other variables (motor encoding, list organization, and rate of presentation) to influence recall. The effects of strategic rehearsal and list organization were also examined. Older adults performed better on organized lists when information was enacted at either encoding or retrieval, resulting in an elimination of age differences in recall. Rehearsal, on the other hand, had no significant influence on age-related performance differences. Finally, Experiment 3 explored factors that could explain the observed discrepancies between studies of SPT recall (no age differences often found) and cognitive activity (age differences consistently found). The findings of Experiment 3 indicated that the discrepant results could not be attributed to presentation rate effects or the differential use of objects. Rather, the age deficit in cognitive activity recall appears to be related to the complexity of the to-be-remembered activities and their labels. It was concluded that the recall probability of SPTs and activities may depend on specific item characteristics that have not been investigated thoroughly. The results were also discussed in terms of older adults' reliance on task-provided cues and strategies. The provision of contextual information during both encoding and retrieval appeared to guide processing so that older adults were able to bring their level of recall up to that of young adults.

INTRODUCTION

Until recently, the typical assessment measure in memory experiments has been based on verbal encoding of words. Because of this tradition, our knowledge of age differences in memory abilities is largely limited to verbal memory tasks such as word list recall and paired-associate learning (Kausler, 1982). Recently, gerontologists have felt the need to expand task domains, particularly to include memory tasks that might be part of the everyday activities of older adults. Activity memory is a fruitful new task domain which provides an opportunity to extend our knowledge of memory performance in the elderly beyond our present focus on the traditional verbal memory tasks.

Several measures have been employed in the aging and activity memory literature (Norris & West, in press). Event memory refers to simulated everyday activities. This requires subjects to complete a related series of actions such as preparing to go on a vacation or taking a tour of a building. Cognitive activity memory has also been investigated in the aging literature. These are sustained mental activities which subjects solve during acquisition, such as Weschler Adult Intelligence Scale (WAIS) items and matching words to pictures. Finally, Subject Performed Tasks (SPTs) are discrete one-step actions which subjects enact during acquisition such as, "Cross your fingers" and "Put the stamp on the book." In contrast to the age-related memory deficit which is seen with traditional verbal measures, studies which have investigated SPTs have frequently found that older adults recall the performed actions as well as young adults (Backman & Nilsson, 1984, 1985; Dick & Kean, 1989). This research project investigated variables which may account for the elimination of age differences in the SPT recall. Three experiments addressed issues which remain unresolved in the current literature on age differences in SPT recall. Experiment 1 investigated the relative benefit of motor cues during encoding and retrieval for young and older adults. In addition, the benefit of list organization for young and older adults was examined. List organization was again manipulated in Experiment 2, as well as the presence of object cues for young and older adults. Finally, Experiment 3 addressed discrepant results concerning age differences in SPT recall and memory for cognitive activities by varying item type, rate of presentation, and presence of objects. As will be later elaborated, age differences in SPT recall have been eliminated (Backman & Nilsson, 1984, 1985; Dick & Kean, 1989), whereas age differences in recall for cognitive activities have consistently been found (Kausler & Hakami, 1983; Kausler, Lichty, & Davis, 1985). The sources of these differences were examined.

The principal models of aging and memory will first be reviewed in order to identify the theoretical foundations of the issues investigated. The specific variables which were manipulated in the experiments will then be examined by reviewing the SPT literature. Finally, the three experiments will be individually reported.

Review of Memory Models in the Aging Literature

Extensive research on memory and aging has provided evidence that there is an age-related decline in secondary memory (Craik, 1977; Kausler, 1982; Poon, 1985). That is, age deficits are not typically found in immediate recall or remote memory, but there is evidence that older adults perform worse than young adults on tasks which require them to learn new information. Three models of the nature and causes of secondary memory deficits in the elderly have been identified (Poon, 1985). These include the biological, processing, and contextual models.

The biological model for age-related memory deficits emphasizes the neurochemical and anatomical changes which occur with normal aging. The following changes in the brain are associated with normal aging: synaptic and neural loss, increased accumulation of lipofuscan, neurofibrillary tangles, changes in neural transmitter substances and synaptic morphology, a reduction in brain size due to neural loss, atrophy of brain cells, and reduced cerebral blood flow (Huyck & Hoyer, 1982). These neuronal and structural changes are more advanced and widespread in demented older adults who have pronounced memory deficits (Moscovitch, 1982a).

While these and other physiological changes are known to occur in the normal aging brain, it is not understood which, if any of these changes, contribute to the cognitive changes seen in the normal, healthy elderly population. Some investigators have emphasized the importance of neurofribillary tangles and senile plaques in explaining age-related memory deficits (Tomlinson, 1972). This explanation has gained credence because tangles and plaques have been observed to a greater extent in dementing patients who have significant memory impairment. Other investigators have emphasized the association between the particular cognitive deficits of the aged and the structural changes in the hippocampus and temporal lobe (Moscovitch, 1982b). These approaches are not necessarily contradictory. As pointed out by Squire (1980), neurofibrillary tangles are most commonly seen in the hippocampal and temporal areas in the nondementing aging brain.

A neurochemical approach has focused on changes in the activity and concentrations of brain neurotransmitters to account for the memory deficits in the elderly (Deutsch, 1973; Hines & Fozard, 1980). Most specifically, a reduction in the hypothalamic catecholamines has been investigated. A decline in memory performance following the administration of an acetylcholine antagonist and a reversal of this condition with the administration of an acetylcholine agonist has been observed in young adults (Drachman, 1977). These experimental manipulations are thought to mimic the neurotransmitter changes that occur with advanced age. In the aging brain, changes in neurotransmitter availability result in diffuse neuronal depletion. This neurochemical change may account for the cognitive changes seen in the elderly.

A neuropsychological perspective, which associates functional deficits in the elderly with the structural changes in the brain, is potentially relevant to the investigation of age differences in SPT recall. Preserved learning capacity which has been observed in amnestic patients has raised questions about the way memory is organized in the brain and differences among kinds of memory systems (N. J. Cohen, 1982; Moscovitch, 1982b). Evidence for preserved learning in amnestic patients (i.e. Korsakoff's, post-encephalitic, bilateral ECT, and diencephalic patients) comes from the ability to perform the following: 1) perceptual-motor tasks such as mirror-tracing and mazes, 2) perceptual tasks such as mirror-reading, 3) cognitive tasks such as the Tower of Hanoi, and 4) priming tasks such as word-completion and lexical decision tasks (N. J. Cohen, 1982). Amnestic patients are able to learn how to perform these tasks after repeated trials, despite their poor recall for having performed the tasks.

N. J. Cohen (1982) proposes that these contradictory performances might be explained by two different memory systems. He suggests that the observed skill learning in amnestics is "procedural" knowledge, or a capacity for "knowing how". In this memory system, information is represented implicitly in the cognitive operations or procedures. Amnestics are capable of learning the rules or procedures for acquiring skills, as required on tasks such as mirror-reading and the Tower of Hanoi. These skills are not distinguished by their motor involvement, but by the nature of the information which is governed by rules or procedures (N. J. Cohen & Squire, 1980). In contrast, those learning skills such as verbal and spatial memory which are impaired in amnestics are referred to as "declarative" knowledge or "knowing that". In this memory system, information is represented explicitly as facts or data, and is accessed directly on demand.

Most experimental investigations of memory are based on the declarative knowledge system (N. J. Cohen, 1982). Impaired memory performance in declarative memory tasks is typically observed in amnestic patients who have damage to the medial temporal or diencephalic brain structures. N. J. Cohen (1982) proposes that procedural and declarative knowledge are mediated by neuroanatomically distinct memory systems, and this accounts for the differences in performance in procedural and declarative memory tasks in amnestics. It is possible that memory for performed actions is another example of procedural knowledge. An age-related memory deficit may be observed with declarative tasks such as word list learning and paired-associate learning, whereas older adults may perform as well as young adults on activity recall because it is procedural in nature.

In summary, the biological model of age-related memory deficits has focused on the following neuronal and structural changes in the aging brain: an increase in neurofibrillary tangles and senile plaques, changes in catecholamine transmitter functioning, and the structural changes in the hippocampal and temporal areas of the brain. A neuropsychological perspective suggests that distinct memory systems may account for the presence of some intact learning skills in amnestics.

Poon (1985) argues that the biological theories are applicable to an elderly population with pathological dysfunction, but this does not account for the memory performance seen in healthy, community-dwelling older adults. The absence of an age deficit in recall in many situations and tasks suggests that investigations should focus on identifying those conditions in which memory changes are observed. Poon (1985) points out that the current challenge in research is the investigation of the frequently observed interactions between individuals, environmental properties, and the task demands. Two other models of aging and memory, the processing models and the contextual model, offer alternatives to the biological explanations of memory deficits in the elderly.

Two approaches have been taken in the processing models of aging and memory. First, there has been an attempt to isolate the stage of processing at which age-related deficits occur. The stages of processing include encoding (i.e., acquisition or learning of the information), storage (i.e., retention of the information), and retrieval (i.e., access of information for recall). The second approach in the aging and memory literature, the information processing or levels-of-processing model, has attempted to distinguish the cognitive operations which characterize the way young and older adults process information to-be-remembered. As shall be seen, there is much overlap between these models.

Extensive research has been conducted in order to determine if deficits in the elderly occur during the storage, encoding, or retrieval stages of processing. According to the storage deficit hypothesis, interference from prior or subsequent material results in weakened memory traces. Hence, the information which was initially encoded is lost during the storage stage. However, there is no evidence for greater susceptibility to interference in older adults (Craik, 1977). Subsequent literature has focused on encoding and retrieval deficits as possible sources for age-related memory deficits.

According to the encoding deficit theory, older adults do not initially learn or acquire the information as well as young adults. Two areas of investigation have provided support for the encoding deficit theory. First, older adults perform as well as young adults when initial learning is equated between the two groups (Schaie & Geiwitz, 1982). That is, older adults may require more repetitions to learn a list of words than young adults, but once the list is learned, young and older adults forget at an equal rate. This implies that the age-related deficit in memory is due to less efficient encoding by the elderly. Second, older adults are thought to be deficient in their use of strategies or mediational processes such as rehearsal, organization, visual association, and verbal elaboration which are presumed to occur at encoding (Poon, 1985). Evidence for this comes from the elimination of age differences in recall when encoding conditions induce subjects to use such strategies (Schaie & Geiwitz, 1982). Hence, when older adults are not guided by such mediational instructions, they recall less due to a deficit at the encoding stage.

According to the retrieval deficit hypothesis, older adults are capable of acquiring and storing information, but they are not as proficient as young adults in retrieving the information. Evidence for the retrieval deficit hypothesis comes from the comparison of young and older adults’ performance on free recall, cued recall, and recognition. In a frequently cited study, Schonfield and Robertson (1966) found a systematic age-related decline in free recall but not in recognition. A decrease in the magnitude of age differences in recall when support is provided during retrieval suggests that older adults' decline in memory performance is due to a retrieval deficit. Similarly, age differences in cued recall are typically less than in free recall (Laurence, 1967; Perlmutter, 1979). This literature suggests that older adults are disadvantaged relative to young adults when retrieval support is not provided (Craik, 1977; Perlmutter & Mitchell, 1982).

Firm conclusions about the encoding versus retrieval debate have not been made. The literature has not conclusively separated encoding and retrieval (Poon, 1985). The evidence which has supported the encoding deficit hypothesis could also be interpreted as evidence for a retrieval deficit in the elderly (Burke & Light, 1981). Support for both encoding and retrieval deficits in older adults has led researchers to speculate that elderly adults have a processing deficit which is common to both the encoding and retrieval stages (Craik, 1977; Perlmutter & Mitchell, 1982).

In contrast to isolating the stage of processing at which age-related deficits occur, the information processing and the levels-of-processing models of aging and memory have focused on characterizing the processing deficit observed in the elderly. According to the information processing model, elderly adults have deficits in their use of mediational techniques such as organization, verbal associations, and visual imagery in determining recall. Young adults have been found to make greater use of elaborative and organizational processes than older adults (Hultsch, 1969). However, when subjects are induced to use various organizational strategies by manipulating the encoding conditions, the performance of older adults improves (Hultsch & Deutsch, 1981). Similarly, Hulicka and Grossman (1967) found that older adults did not report use of imagery in a paired-associates learning task, but when instructed to use mediators the older adults' recall approached that of young adults.

The levels-of-processing model, initially proposed by Craik and Lockhart (1972), uses an orienting paradigm in which incidental recall (that is, performance on an unexpected memory test) is tested after the subjects' attention has been directed to particular features of the information to-be-remembered. According to the levels-of-processing model, items are encoded along a continuum from shallow to deep levels depending on what features were attended to as a result of the orienting task. Hence, only shallow processing occurs when ones' attention is directed to surface features such as the phonemic characteristics of the item list, resulting in a fragile memory trace. Directing attention to semantic features of the item list, on the other hand, requires deep processing and will result in a more stable memory trace. The levels-of-processing model hypothesizes that the age-related memory deficit is due to shallow processing of the to-be-remembered information in elderly adults. This is supported by evidence that age differences are eliminated or minimized when older adults are provided with semantic orienting tasks at encoding (Craik & Simon, 1980; Perlmutter & Mitchell, 1982).

A final perspective on human memory is the contextual model. This model views cognition as a dynamic process involving an interaction of the physical, social, and psychological contexts in which the individual executes the task. The information which is learned depends not only on the individuals' current cognitive processes, but also on the context in which the information was learned, such as the specific task demands, as well as the motivations and abilities which the individual brings into the situation (Hultsch & Deutsch, 1981).

Many contextual variables have been investigated including individual expectation and motivations, item familiarity, pre-experimental knowledge, and verbal abilities (Poon, 1985). Much of this literature has found age by test conditions interactions suggesting that age-related memory deficits may be exaggerated by experimental conditions which favor young adults. For example, several studies using different test material including word lists, content of television programs, and prose found that age differences in recall are eliminated when older adults with low verbal skills are excluded (Bowles & Poon, 1982; Cavanaugh, 1983; Taub, 1979). Other investigators have used material that is differentially familiar to older and young adults (Botwinick & Storandt, 1980; Hultsch & Dixon, 1983; Poon & Fozard, 1978). These studies found that older adults perform as well, or better, than young adults when the information to-be-remembered, such as entertainment figures, socio-historic information, and pictured objects were familiar to the older cohort.

These studies suggest that the types of materials used to compare the memory performance of young and older adults are major determiners of the magnitude of the observed age-related differences (Poon & Fozard, 1978).

According to the contextual model, recall will improve when the to-be-remembered information is presented within a meaningful context. Hence, the contextual model has emphasized ecologically valid measures which are meaningful to the individuals' everyday life rather than the traditional laboratory tests such as word lists and paired-associate learning tasks. The role of context in everyday memory demands has been pointed out by Burke and Light (1981). For instance, remembering whether or not one has taken one's medication depends to a great extent on the specific contextual memories that accompany that individual occasion and distinguish it from other instances of the same event. The contextual model of human memory has, therefore, been considered to be more relevant to individuals' everyday memory performance than traditional models.

As previously mentioned, there is overlap between the models reviewed. Processes such as organization and mediation which are emphasized in the information processing model, can also be viewed as methods of deep processing (Schaie & Geiwitz, 1982). In addition, the processing deficits seen in elderly adults may be applied to both the encoding and retrieval stages (Craik, 1977). That is, recall will improve when an event is deeply encoded and when similar deep cues are provided at retrieval. Similarly, the provision of cues in memory tasks, whether they are verbal associations as examined by the information processing model or item familiarity as examined by the contextual model, can be viewed as guided memory tasks which older adults perform as well on as young adults. It is important to acknowledge the overlap in these theories. Experimental findings can be interpreted in light of more than one theory.

In summary, three models of age-related memory deficits have been reviewed in order to provide a theoretical background. The biological model points to neurochemical and structural changes in the aging brain which may account for the memory decline in older adults. Processing models have focused on isolating the stage of processing deficits and the level of processing which characterizes the age-related memory deficits. Age deficits have been implicated at both the encoding and retrieval stages of processing, but not at the storage stage. The information processing model has focused on the reduced use of mediational techniques, such as organization, verbal associations, and visual imagery in determining recall in the elderly. The levels-of-processing model hypothesizes that the elderly process information at a more shallow level than young adults, resulting in a less stable memory trace. Finally, the contextual model of memory proposes that the information which is learned depends not only on cognitive processes, but also on the context in which the information was learned. Hence, age may interact with contextual variables such as expectations and motivations, item familiarity, and pre-experimental knowledge. The overlap of these models makes it possible to interpret research findings according to more than one model.

The Significance of SPT Research for Aging

Recall of Subject Performed Tasks (SPTs) was first introduced by R. L. Cohen (1981) in order to investigate the generality of commonly accepted laws of memory. SPT recall requires the subject to perform a list of activities, such as "lift the spoon", "rub your eyes", and "name four colors", which is followed by free recall. R. L. Cohen (1981) characterizes traditional verbal recall tasks as a one-way interaction between the subject and the environment; that is, the environment exerts an effect on the subject, but the subject does not exert any observable effect on the environment. SPTs, on the other hand, are two-way interactions because this event also involves an observable manipulation of the environment by the subject.

R. L. Cohen (1981, 1983) points out that hypotheses concerning the laws of memory have been exclusively based on verbal tasks such as free recall of word lists. In order to test the generality of these laws, he and his colleagues have investigated the following memory laws in SPT recall: serial position effects, strategic processing, and levels-of-processing effects. In serial position analyses, an absence of the primacy effect has repeatedly been observed (Backman & Nilsson, 1984, 1985; R. L. Cohen, 1981, 1983). A primacy effect, that is, greater recall for the first few items on a list, is thought to be indicative of rehearsal of those earlier items (Rundus & Atkinson, 1970). The absence of a primacy effect suggests that rehearsal is not as important in SPT recall as it is in word recall. In addition, there is evidence that strategic processing plays a minor role in SPT recall. Subjects report that they actively tried to memorize word lists, but they performed SPTs without active attempts to memorize them (R. L. Cohen, 1981). This occurred despite the subjects' equivalent recall of words and SPT lists. Furthermore, unlike the levels-of-processing effects found in word list recall, orienting tasks which called for shallow versus deep processing did not influence the rate of SPT recall (R. L. Cohen, 1981). It is possible that an age-related memory deficit is not observed in SPT recall because older adults are thought to have processing deficits (Craik, 1977), and therefore, may perform better on measures such as SPT recall which do not require deep or strategic processing. These findings suggest that our knowledge about memory performance should not be based solely on traditional verbal recall tasks because other memory tasks, such as SPTs, appear to be governed by different memory laws and this may influence older adults' performance.

SPT recall is an important area of research for understanding age-related changes in memory for several reasons. First, there is a need for more ecologically valid approaches to the assessment of memory changes in the elderly. An ecological approach to memory assessment has been advocated by gerontologists (Baddeley & Wilkins, 1984; Botwinick, 1984). An important ingredient in an adequate ecological assessment is its relevance to the memory complaints of older adults. Studies show that memory for activities are among the most common problems identified by elderly adults (Cavanaugh, Grady, & Perlmutter, 1983; Chaffin & Hermann, 1983). Unlike traditional laboratory tests such as word lists and paired-associate learning, SPTs resemble the memory for activities demands which occur in one's daily life. SPT recall and memory for everyday activities are similar in that they both provide motor cues, and in R. L. Cohen's (1981) terms, both involve a two-way interaction between the individual and the environment.

Another reason why the investigation of SPT recall is important for understanding adult age differences in memory is because the lack of age differences found in SPT recall represents an instance in which older adults learn new information as well as young adults. This challenges the widely accepted notion that older adults have a deficit in secondary memory. Geropsychologists must ask whether secondary memory deficits in older adults are limited to a particular class of tasks. As previously pointed out, Poon (1985) asserts that the current challenge of aging research is to specify those conditions in which age-related memory deficits occur by testing for interactions between age groups and task conditions. The observed age (young vs. old) by task (verbal task vs. SPT) interaction has been attributed to the elderly compensating for cognitive deficits by using various contextual aids provided by kinesthetic, visual, auditory, and tactile cues (Backman & Nilsson, 1984, 1985). The source for this interaction needs further investigation in order to more clearly understand the reasons why age differences in memory are eliminated in SPT recall and to more precisely define those conditions under which older adults perform as well as young adults.

Finally, SPT recall is an important area of investigation for aging research because it provides an experimental paradigm in which the relative importance of encoding and retrieval operations in age-related memory deficits can be controlled and investigated. As previously pointed out, both encoding and retrieval operations have been implicated in accounting for age-related memory deficits (Craik, 1977; Smith, 1977). The study of SPT recall allows for the experimental manipulation of cues provided during both encoding and retrieval.

The reasons for investigating the lack of age differences in SPT recall have been pointed out. SPTs are a more ecologically valid measure of memory performance than traditional verbal recall tests. Also, SPT recall represents an instance in which older adults learn new information as well as young adults. The reasons for older adults' improved performance on SPT recall needs further investigation. Finally, SPT recall provides a paradigm in which both encoding and retrieval processes can be examined. The SPT literature will next be reviewed in order to identify those variables which have been thought to account for the elimination of age differences in SPT recall. These include: motor cues, object cues, strategic processes, task-related differences, and rate of presentation.

Motor Cues and Age Differences in SPT Recall

A critical distinction between SPTs and verbal memory tasks is that SPTs are multimodal, whereas verbal memory tasks are typically unimodal or bimodal (Backman & Nilsson, 1984, 1985). SPTs are multimodal in that all five sensory systems may be involved during presentation of the material. SPT encoding may include auditory, visual, motor, tactual, and even olfactory and gustatory registration. For example, the information is processed visually because there are objects present. There is motor processing as the subjects carry out the action required of the SPT items, and there is tactual processing by the touching of various objects. Furthermore, some SPT items such as "smell the flower" and "eat the candy" involve the olfactory and gustatory systems. Verbal memory tasks, on the other hand, are typically presented either auditorily or visually by reading the items to the subjects or having the subjects read items from slides or cards. Backman and Nilsson (1984, 1985) suggest that older adults are capable of compensating for their memory deficit when multimodal cues are available. Their research has focused primarily on the influence of such cues in eliminating age differences in SPT recall.

The presence of motor cues is a particularly important distinction between SPT and verbal recall. Motor cues are almost always present in SPTs and presumably never present in verbal recall tasks. Hence, motor cues may be the most important sensory system in the multimodal processing of SPTs. Evidence to confirm the hypothesis that motor cues are important in eliminating age differences in SPT recall comes from the following findings: 1) Older adults were not as adept as young adults in recalling sentence descriptions of SPTs (Backman & Nilsson, 1984, 1985). 2) Age differences were also found in recall when subjects imagined performing the task described in the sentence (Backman & Nilsson, 1985). 3) Age differences were also found for recall of sentences when the objects were present suggesting that the object cue alone was not critical for recall among older adults (Backman, 1985). These results suggest that the motor cues provided by the performance of SPTs accounts for the elimination of age differences in SPT recall.

Others have compared age differences in memory for motor and cognitive activities to examine the role of motor cues in age differences in activity memory (Lichty, Kausler, & Martinez, 1986). Subjects were tested for recall of motor activities such as cutting shapes, connecting rings, and clay modeling. They were also given cognitive activities to recall such as estimation of length, incomplete words, and word search. Young adults recalled both types of activities better than older adults and it was concluded that motor involvement is an unimportant predictor in the magnitude of age differences in activity recall. However, other variables may account for the age deficit found in activity memory by Lichty et al. (1986). As the authors suggest, the activities which they employed may be less familiar to older adults than young adults. In addition, the information to-be-remembered was unfamiliar--subjects had to recall task labels such as "connecting rings" and "word search". Lastly, subjects in the Lichty et al. (1986) experiment engaged in the activities for three minutes, whereas Backman and Nilsson (1984, 1985) had subjects perform SPTs for five seconds. Hence, while there is some evidence that motor cues are not the critical variable in eliminating age differences in SPT recall, the age deficit found in Lichty et al. (1986) may be explained by other experimental procedural differences.

In addition to trying to clarify whether motor cues are important in eliminating an age-related memory deficit, the relative influence of motor cues during encoding and retrieval is an important aspect of investigating the lack of age differences in SPT recall. Various investigators in SPT and activity memory have attributed age-deficits on standard memory lists to either encoding or retrieval deficits in the elderly. R. L. Cohen (1981, 1983) maintains that encoding mechanisms are not important in SPT recall. His evidence for this includes the following: 1) a primacy effect is not observed in SPT recall suggesting limited use of rehearsal, 2) subjects report that they performed SPTs without actively attempting to use memorization strategies, and 3) there is no effect on SPT recall when subjects' attention is to diverted to deep versus shallow features of SPT items. R. L. Cohen (1981) argues that encoding mechanisms are of little importance in SPT recall and that a model of SPT memory requires a shift of emphasis from encoding to retrieval mechanisms.

In contrast, Backman and Nilsson's (1984, 1985) experimental design which manipulates motor cues only during encoding has emphasized the importance of encoding in SPT recall. They propose that young adults recall verbal tasks as well as SPTs because they are able to take the initial event and spontaneously recode the event in terms of other contextual cues. The elderly, on the other hand, require the additional contextual cues during encoding in order to bring their level of recall up to that of young adults. This implies that the elderly have an encoding deficit.

Kausler and his colleagues have implicated both encoding and retrieval deficits in memory for cognitive activities. There is no difference in recall between intentional and incidental instructions, providing further evidence that activity memory is independent of rehearsal and that encoding mechanisms are relatively unimportant (Kausler & Hakami, 1983). Hence, the age deficit they found in activity memory may be attributable to a retrieval deficit in the elderly (Kausler & Hakami, 1983). An age deficit in recognition for cognitive activities, however, also implies that the elderly have an encoding deficit in activity memory (Kausler, Lichty, Hakami, & Freund, 1986). Age differences in activity recall are predicted when young adults are more likely to encode contextual information which is again elicited at retrieval (Kausler & Lichty, 1988).

Activity memory studies have manipulated motor cues during encoding (Backman, 1985; Backman & Nilsson, 1984, 1985; R, L. Cohen, 1981; Dick & Kean, 1989; Kausler & Hakami, 1983; Kausler et al., 1986). That is, items were presented with motor cues by having the subjects perform the tasks as the experimenter read the items. Recall, however, required a verbal description of the tasks. This procedure does not allow for an investigation of the influence of motor cues during retrieval on activity recall. In more recent studies using an event paradigm, motor cues have been manipulated during both encoding and retrieval allowing for the comparison of the following task conditions: 1) verbal encoding/verbal retrieval, 2) verbal encoding/ motor retrieval, 3) motor encoding/verbal retrieval, and 4) motor encoding/motor retrieval (Norris & West, 1988; Saltz, 1988). Norris and West (1988) found that age differences in event memory were eliminated only in the motor encoding/verbal retrieval condition, thus, replicating the findings from earlier studies (Backman

& Nilsson, 1984, 1985; Dick & Kean, 1989). In contrast, Saltz (1988) found support for the retrieval deficit hypothesis in a study which investigated subjects' recall for sentences (e.g., "The teacher pointed a finger at the blackboard"). Motor enactment of the sentence verbs was varied at both encoding and retrieval. Motor processing during retrieval was differentially beneficial to older adults suggesting that cues during retrieval are more important in eliminating age differences in recall.

In summary, motor cues are a critical distinction between SPT and traditional verbal recall tests, and hence, may be an important influence in eliminating age differences in SPT recall. There is evidence that motor cues during encoding are important in eliminating age differences in SPT and event recall. However, some investigations have found evidence that retrieval mechanisms may be more important than encoding mechanisms. The relative benefit of motor cues during encoding and retrieval is addressed in Experiment 1 by manipulating motor cues during both encoding and retrieval.

Object Cues and Age Differences in SPT Recall

It has been argued that older adults perform better on SPT recall than traditional verbal memory tasks because SPTs involve multiple sensory systems (Backman, 1985; Backman & Nilsson, 1984, 1985). As previously reviewed, there is support that motor cues are important in eliminating age differences in SPT recall (Backman & Nilsson, 1984, 1985; Dick & Kean, 1989). However, it may be that the presence of motor cues per se is less important than the multimodal property of SPTs. In order to address the multimodal hypothesis there must be evidence that older adults benefit from cues other than motor cues. The importance of object cues during encoding in SPT recall has also been investigated.

Motor cues were varied in a study which compared young and older adults on recall of SPTs and sentences with objects present (Backman, 1985). Age differences were eliminated in SPT recall, whereas young adults recalled the sentences with objects present better than older adults. This suggests that the presence of objects during encoding plays a minor role with respect to the lack of age differences in SPT recall and that the critical task properties in eliminating age differences in SPT recall are the motor cues provided by the performance of the task items.

No studies have compared young and older adults on recall of SPT items with objects present and SPT items without objects present in order to determine if motor cues alone, or the combination of motor and object cues accounts for the elimination of age differences in SPT recall. SPT items with objects and items without objects have been compared using both young samples and young and older subjects with the data collapsed over age groups. In most studies, no differences in recall of SPT items with and without objects have been found (Backman & Nilsson, 1984; R. L. Cohen, 1988; R. L. Cohen, Peterson, & Mantini-Atkinson, 1987, Experiment 1). Others have found that the presence of objects sometimes facilitates recall (Helstrup, 1986, 1987); yet other data showed that objects may impair recall (R. L. Cohen, Peterson & Mantini-Atkinson, 1987, Experiment 2). These studies did not compare young and older subjects, and therefore, does not address the question of whether object cues are important in eliminating age differences in SPT recall.

Age differences in SPT recall have been found when items were not present (Guttentag & Hunt, 1988; Knopf & Neidhardt, 1989). In one study, items were typical of most SPT studies; however, no objects were presented and subjects pantomimed the SPT actions (Knopf & Neidhardt, 1989). For example, no objects were presented for items such as "put on a cap" and "throw a lasso" and subjects pretended to perform the actions. Young adults recalled more items than older adults. In a second study, subjects were given actions to perform which did not require the use of objects, such as "shake your head yes" and "touch your knee" (Guttentag & Hunt, 1988). Again, an age-related deficit in recall was found. These studies suggest that motor cues alone may not be sufficient to eliminate age differences in SPT recall. As predicted by the multimodal hypothesis, perhaps the combination of motor and object cues are important in eliminating age differences in SPT recall.

In summary, object cues alone do not appear to eliminate age differences in recall. When object cues are combined with motor cues in SPT recall, there is usually no increase in recall for young and older adults collapsed over age groups. However, these studies do not address the role of object cues in SPT recall as a function of age. Support for the multimodal hypothesis comes from studies which found that age differences in SPT recall remain when items are enacted but do not provide object cues. There are no studies which have varied the presence of objects and compared young and older adults' recall performance. Experiment 2 compared young and older adults for recall of SPT items with objects and items without objects in order to address the role of objects in eliminating age differences in SPT recall.

The Influence of Strategic Processing on Age Differences in SPT Recall

It has been argued that age differences in SPT recall are eliminated because SPT recall is nonstrategic (R. L. Cohen, 1981, 1983). In contrast, verbal recall is thought to be strategic, and thus favors young adults who are able to spontaneously use organization techniques, visual imagery, verbal association, etc. Several pieces of evidence have been cited to support the notion that SPT recall is nonstrategic: 1) a primacy effect which implicates the use of rehearsal is not observed in SPT recall (Backman & Nilsson, 1984, 1985; R. L. Cohen, 1981, 1983), 2) subjects report no attempt to memorize during SPT presentation (R. L. Cohen, 1981, 1983), and 3) populations who are presumed to have strategy deficits such as young children, older adults, and educably mentally retarded adults are not penalized in tests of SPT recall (Backman, 1985; Backman & Nilsson, 1984, 1985; R. L. Cohen & Bean, 1983; R. L. Cohen & Stewart, 1982; Dick & Kean, 1989).

The strategic processes which the SPT literature has focused on are rehearsal and organization. Rehearsal memorization strategies are indicated by a primacy effect in which early items on the list are recalled at a higher rate (Rundus & Atkinson, 1970; Atkinson & Shiffrin, 1971). There is agreement that a primacy effect is not seen in SPT recall (Backman & Nilsson, 1984, 1985; R. L. Cohen, 1981, 1983). This is strong evidence that SPTs are encoded without rehearsal.

The use of organization in SPT recall has also been investigated in the literature but without such clear findings. Evidence for the use of organization has cast doubt on the notion that SPT recall is nonstrategic in all respects. A comparison of two lists of SPTs and sentences, one list which could be organized into five superordinate categories and one list which could not be organized, showed that the unorganized lists caused greater impairment in SPT recall than sentence recall (Backman, Nilsson, & Chalom, 1986). They conclude that SPT recall is dependent on organization, and therefore, is not entirely nonstrategic.

Backman and Nilsson (1984, 1985) suggest that the multidimensional task properties of SPTs enhance the detection of superordinate categories for older adults and this may account for the lack of age differences in SPT recall. These multidimensional task properties allow SPTs to be organized by whether or not objects are present, by the imperatives of the acts (e.g. "name", "put", etc.), or by semantic categories (e.g. parts of body, toys, etc.). Using ARC clustering scores, it was found that SPTs were organized to a greater extent than comparable verbal tasks, providing further evidence that SPTs are not entirely nonstrategic (Backman & Nilsson, 1984, 1985). Although there were no age differences in ARC scores, the age by task interaction found for recall was not found for cluster scores. This suggests that the elimination of age differences in SPT recall is not due to older adults' enhanced detection of superordinate categories in SPTs. However, the detection of superordinate categories may have been reduced because ARC scores were based only on two superordinate categories, items which used objects versus those that did not. The absence of a relationship between organization and recall was also found when cluster scores were based on motor versus cognitive activities (Lichty et al., 1986). It is possible that the use of only two categories does not provided enough opportunity for organization to show age differences.

There is some evidence that age differences in recall are eliminated in memory for events which have an organized structure (Padgett & Ratner, 1987). However, this study did not analyze the data using a cluster score as a dependent measure. Therefore, it cannot be determined whether the elimination of age differences in recall was due to the older adults' benefiting from clustering.

The effect of organization on event memory was also explored in a study which varied verbal and motor processing at both encoding and retrieval (Norris & West, 1988). The young adults made greater use of organization in all conditions except the motor encoding/verbal retrieval condition. This was also the only condition which did not show age differences in recall. These results suggest that under certain conditions young adults make greater use of organization than older adults, and this may result in age differences in recall. The finding that young and older adults were equivalent both in recall of SPTs and organization of SPTs (Backman & Nilsson, 1984, 1985) may be specific only to the motor encoding/verbal retrieval condition. However, Norris and West (1988) tested for recall of event memory, not SPTs, and their results may not be replicated using SPT recall as the dependent measure.

In summary, it is possible that age differences in SPT recall are eliminated because SPT recall is nonstrategic. The superior performance of young adults on verbal recall tasks is thought to be due to their spontaneous use of strategies such as rehearsal and organization. The absence of a primacy effect in SPT recall is evidence that rehearsal is not important in SPT recall. On the other hand, evidence for the use of organization in SPT recall has suggested that SPT recall is not entirely nonstrategic. Although organization appears to improve SPT recall more than sentence recall, the nonsignificant age by task interaction provides evidence that older adults do not differentially benefit from organizational strategies in SPT recall. Organization may not account for the elimination of age differences in SPT recall although these studies may not have included enough superordinate categories to elicit organization strategies. It has also been suggested in the literature that the absence of age differences in organization and recall varies across conditions. Experiments 1 and 2 examine age differences in the use of organization in SPT recall with items from four superordinate categories and under conditions which vary motor cues during both encoding and retrieval.

Age Differences in SPT Recall and Memory for Cognitive Activities

As previously reviewed, age differences have been eliminated in SPT recall (Backman, 1985; Backman & Nilsson, 1984, 1985; Dick & Kean, 1989). In contrast, experiments in memory for cognitive activities have consistently found an age-related deficit in recall (Kausler & Hakami, 1983; Kausler, Lichty, & Davis, 1985; Kausler, Lichty, & Freund, 1985; Kausler et al., 1986; Lichty et al., 1986). This differential outcome has occurred in spite of many similarities between the two types of tasks (Kausler & Lichty, 1988). There are several possible reasons for the discrepant findings. The first obvious distinction between the SPT and cognitive activity studies concerns different characteristics in the type of item or task employed. In addition, different procedures used in the studies such as the rate of presentation of items may account for the discrepant results.

There are important distinctions between SPT and cognitive items which may account for the discrepant results concerning age differences in recall. SPTs are discrete one-step actions which are typically motorically performed. In contrast, Kausler and his colleagues have tested for recall of cognitive activities such as word-picture naming, serial learning, and WAIS Information and Arithmetic items. Unlike SPTs, these activities are continuous actions in which motor involvement is mostly limited to paper and pen activity, and as such are primarily cognitive in nature. A few cognitive activity tasks provide motor cues, such as object assembly and card sorting, but these are not typical. It is possible that the discrepant results from the SPT and cognitive activity memory studies occur because SPT actions provide older adults with motor cues that they would not otherwise spontaneously generate.

Age differences in recall of motor and cognitive activities were compared to address the role of motor cues in eliminating age differences in activity recall (Lichty et al., 1986). Age differences favoring the young adults were significant for both motor and cognitive activities suggesting that the discrepant results in the literature is not due to motor cues. As previously mentioned, the age deficit found for recall of motor activities may be accounted for by other factors including task familiarity, task labels, and rate of presentation.

Activity memory was also investigated by Norris and West (1988). In agreement with the SPT literature (Backman, 1985; Backman & Nilsson, 1984,1985; Dick & Kean, 1989), age differences were eliminated in the motor encoding/verbal retrieval condition. On the other hand, in agreement with Kausler and his colleagues, Norris and West (1988) found that age differences persisted in the other two conditions in which motor cues were provided during retrieval. This supports the conclusion drawn by Lichty et al. (1986)

that motor cues are not critical in eliminating age differences in activity memory.

In addition to the different items or tasks used in the SPT and cognitive activity memory studies, another important difference which may account for the contradictory results is the rate at which items are presented. In the SPT literature, items have been presented at 5-8 second intervals. In contrast, the cognitive activity memory studies have had subjects perform activities for intervals of 45-180 seconds. It is possible that rate of presentation, rather than item type differences, accounts for the contradictory results found in the SPT and cognitive activity studies.

Rate of presentation was explored in a study in which subjects engaged in activities for 45, 90, and 180 seconds (Kausler et al., 1986). Young adults recalled more than older adults at all three rates of presentation. They concluded that activity duration has a negligible effect on the magnitude of age deficits in recall. However, this study did not address the lack of age differences found in the SPT studies in which items are presented at 5-8 second intervals, a significantly briefer period than tested by Kausler et al. (1986).

The elimination of age differences in recall under fast presentation conditions is counter-indicated by Salthouse's (1985) speed hypothesis which states that older adults' cognitive deficits are due to slower processing. The slowing hypothesis is supported by evidence that older adults perform better when testing procedures allow them to perform at their own pace. This data would suggest that older adults should be penalized by the fast presentation rates of SPTs and that age differences might be reduced in cognitive activity studies which present tasks for longer periods; in fact, the reverse is found.

It is possible that the very brief presentation rate of SPTs prohibits elaborate processing which would otherwise benefit young adults. Support for this comes from the following: Young adults' recall was reduced to a level comparable to that of elderly adults when encoding time was restricted (Simon, 1979). In addition, Craik and Rabinowitz (1985) found that the magnitude of the age-related memory deficit was increased with longer presentation rates. They argue that longer encoding times are beneficial to young adults because this gives them the additional time needed to carry out effective procesing operations which older adults fail to do when not guided by environmental support. Hence, the contradictory results in the SPT and cognitive activity literature may be explained by the differences in the rate of presentation.

In summary, age differences have been eliminated in SPT recall, but remain in cognitive activity memory. Different factors may account for the discrepant results. First, there are important item distinctions such as the prevalence of motor cues in SPTs. Alternatively, the discrepant results may be due to important procedural differences such as the rate of presentation in the SPT and cognitive activity studies. Item type and rate of presentation were varied in Experiment 3 in order to identify what variables may account for the discrepant results in the SPT and cognitive activity memory literature.

The models of memory and aging reviewed earlier provide principles which may explain why age differences in recall are eliminated when motor, object, and organization cues are provided. A neuropsychological explanation for the elimination of age differences in SPT recall specifically addresses the benefit of motor cues. As previously reviewed, preserved learning in amnestics may be accounted for by two distinct neuroanatomically memory systems which govern declarative and procedural knowledge (N. J. Cohen, 1982). The elimination of age differences in the motor encoding/verbal retrieval condition is arguably an example of declarative knowledge. Hence, the absence of an age-related memory deficit in SPT recall cannot be accounted for by defining it as a procedural memory task. Nevertheless, there may be a distinction between SPT and verbal recall tasks based on neuroanatomical differences. Older adults' improved memory performance when actions are performed may be due to the relative sparing of the cortical motor areas in normal aging (Winbald, Hardy, Backman, & Nilsson, 1985). A neurochemical basis for the preservation of memory when motor cues are provided has also been implicated. Research has demonstrated that neurotransmitter changes associated with aging are not anatomically uniform but vary in different brain regions (Allen et al., 1983; Strong, 1985). Winbald et al. (1985) have also proposed that older adults may recall performed actions as well as young adults because concentrations of dopamine, a critical neurotransmitter for motor functions, are not reduced in the hippocampus with age. It is possible that the elimination of age differences in SPT recall is due to the sparing of structural areas and neurochemical processes associated with motor activity.

Alternatively, the contextual model suggests that the motor, object, or organization cues, or their combination, benefits older adults by providing them with information that is not otherwise spontaneously processed, as occurs with young adults. According to the contextual model of memory and aging, an age-related memory deficit is found when the specific task demands and the material to-be-remembered is not appropriately familiar and meaningful to older adults. According to Backman & Nilsson (1984, 1985), older adults are less likely to spontaneously encode less contextually rich material such as verbal tasks. In contrast, young adults are able to take only the semantic cues provided by verbal recall tasks and "spontaneously recode" the task in terms of all the potential contextual cues (Backman & Nilsson, 1984, 1985). This is supported by the finding that young adults' recall of SPTs is not greater than their recall of comparable verbal tasks (Backman, 1985; Backman & Nilsson, 1984, 1985). The motor performance of SPTs, the object cues, and the enhanced detection of superordinate categories may provide additional contextual information which enhances recall for older adults, whereas the additional information provided by these cues would be redundant to young adults.

In conclusion, this research project investigated some of the variables which may contribute to the lack of age differences in SPT recall. Motor cues, an important distinction between SPT and traditional verbal recall tasks, was varied during both the encoding and retrieval stages. In order to investigate the multimodal hypothesis the benefit of object cues to older in activity recall was also analyzed. In addition, the use of organization in SPT recall was examined in order to investigate the hypothesis that the lack of age differences in SPT recall is due to nonstrategic processing. Finally, contradictory results in the SPT and cognitive activity memory literature were examined by varying item type and the rate of presentation.

EXPERIMENT 1

Introduction

Extensive research on memory and aging has shown that there is an age-related decline in secondary memory (Craik, 1977; Kausler, 1982; Poon, 1985). Recent research has suggested that this observed age deficit in recall for newly acquired information may need to be qualified. In contrast to verbal recall tasks, age differences have often been eliminated in the recall of Subject Performed Tasks (SPTs) (Backman & Nilsson, 1984, 1985; G. Cohen & Faulkner, 1989; Dick & Kean, 1989). A critical distinction between SPTs and traditional verbal recall tasks is that verbal memory tasks are typically limited to auditory or visual registration of the material, whereas SPTs provide multimodal cues. SPT encoding may provide auditory, visual, motor, tactual, and even olfactory and gustatory registration of the material. The purpose of this study is to examine the role of cues and strategic processing in eliminating age differences in SPT recall.

Age differences in verbal recall tasks have been attributed to young adults' ability to spontaneously generate cues and strategies for remembering information. In contrast, older adults are less able to generate cues on their own and may need to rely on cues provided by either the examiner or the test conditions (Hultsch & Deutsch, 1981). Age differences in SPT recall may be eliminated because older adults benefit from the additional contextual cues which are provided by the test conditions. In contrast to verbal recall tasks, SPTs provide multimodal cues such as motor, visual, auditory, and tactile cues. Hence, age differences in recall are eliminated because older adults do not have to rely on generating cues for themselves (Backman & Nilsson, 1984, 1985).

The cues which have been emphasized in the SPT literature are motor cues provided by the enactment of the task and visual cues provided by the presence of objects. Motor cues are a particularly important distinction between SPTs and verbal recall tasks because motor cues are almost always present in SPTs and presumably never present in verbal recall tasks. Evidence for the importance of motor cues in eliminating age differences in SPT recall comes from studies which have controlled for motor cues under various SPT conditions. Age differences were observed in the recall of sentence descriptions of SPTs, sentences with the objects present, sentences with instructions to imagine performing the action, and examiner performed actions. In contrast, age differences were eliminated in the recall of SPTs when subjects performed the action during encoding (Backman, 1985; Backman & Nilsson, 1984, 1985; G. Cohen & Faulkner, 1989; Dick & Kean, 1989). These results suggest that the motor cues provided in SPT recall are a critical variable in eliminating age differences in recall.

SPT studies have emphasized the importance of motor cues provided during encoding but motor cues could also enhance retrieval processes. The relative influence of motor cues during encoding and retrieval is an important aspect of investigating the elimination of age differences in SPT recall. Various investigators have attributed the age-related decline in verbal recall to either encoding or retrieval deficits in the elderly. Within the memory for activity literature, R. L. Cohen (1981, 1983) has emphasized the importance of retrieval mechanisms in activity recall, Backman and Nilsson (1984, 1985) have focused on encoding processes as critical in activity recall, and Kausler and his colleagues have implicated both encoding and retrieval operations in influencing activity recall (Kausler & Hakami, 1983; Kausler et al., 1986). SPTs are a useful way of examining both encoding and retrieval processes because motor cues can be varied at both stages.

It is possible that age differences are eliminated in SPT recall for reasons other than the presence of motor cues. It has also been argued that age differences in SPT recall are eliminated because SPT recall is nonstrategic (R. L. Cohen, 1981, 1983). Verbal recall is enhanced by strategies such as rehearsal, organization, verbal association, and visual imagery. Age differences in the recall of verbal tasks have been attributed to young adults' spontaneous use of these strategies. In contrast, older adults are thought to be less efficient at spontaneously using such strategies (Hultsch & Deutsch, 1981).

Two strategies, rehearsal and organization, have been addressed in the activity literature. There is evidence that subjects do not engage in rehearsal during SPT learning because early items from a SPT list are not recalled at a higher rate than middle items, as is typically seen in verbal recall. When early items are recalled at a higher rate, called a primacy effect, it is interpreted as evidence for rehearsal (Atkinson & Shiffrin, 1971). This absence of a primacy effect provides evidence for the nonstrategic nature of SPT encoding (Backman & Nilsson, 1984, 1985; R. L. Cohen, 1981, 1983).

In addition to rehearsal, organization in SPT recall has been examined in order to investigate the role of strategic processing in eliminating age differences in SPT recall. It has been suggested that the multidimensional task properties of SPTs enhance the detection of categories by older adults and that this may account for the lack of age differences in SPT recall (Backman & Nilsson, 1984, 1985). Older adults may improve their performance in SPT recall because they organize the list into semantic categories (e.g. parts of body, toys), items with and without objects, or types of actions (e.g. "name", "put").

The literature has produced contradictory results concerning organization. Some studies suggest that the elimination of age differences can not be attributed to enhanced organizational processing by older adults.

The age (young vs older adults) by condition (verbal vs SPT tasks) interaction found for SPT recall was not found using clustering scores (ARC) based on the grouping of items with and without objects (Backman & Nilsson, 1984, 1985). This indicates that the degree of age differences in clustering does not vary across conditions and suggests that older adults' improved performance in SPT recall is not due to clustering. In addition, age differences were not eliminated for the recall of a highly organized tour-taking event (Padgett & Ratner, 1987). In contrast, other studies suggest that older adults may benefit from highly organized material and bring their level of recall up to that of the young adults. Age differences were eliminated in the recall of an organized clay-making event (Padgett & Ratner, 1987). In addition, age differences in event memory were eliminated only in the condition (motor encoding/verbal retrieval) in which age differences in organization were also eliminated (Norris and West, 1988).

In the SPT literature, the preponderance of evidence suggests that both young and older adults's recall improves with organized material (Backman & Nilsson, 1984, 1985). However, the age by task interaction found for recall has not been found when cluster scores are used as the dependent measure suggesting. The pattern of age differences in clustering appears to be the same for SPTs and verbal recall. Older adults do not appear to differentially benefit from organizational strategies in activity recall as compared to verbal recall (Backman & Nilsson, 1984, 1985; Lichty et al., 1986). Hence, organization may not account for the elimination of age differences in SPT recall.

There was a limitation, however, in the earlier research. These studies restricted organization to only two categories. This may not have provided sufficient organizational cues for older adults to improve their recall. When multiple categories for organization were provided, age differences in recall were eliminated in the condition which also eliminated age differences in organization (Norris & West, 1988).

In summary, the activity literature suggests that age differences in recall of SPTs may be eliminated because older adults may benefit from motor cues and/or organizational cues. This study varied motor cues during the encoding and retrieval stages in SPT recall, and varied list organization. The following four conditions were compared: verbal encoding/verbal retrieval, verbal encoding/motor retrieval, motor encoding/verbal retrieval, and motor encoding/motor retrieval. In addition, two lists were used to test for recall, one list in which the items could be organized into four categories, and a second list in which items could not be readily organized.

Four hypotheses concerning motor cues were examined. First, it was hypothesized that the young adults would recall more than the older adults in the verbal encoding/verbal retrieval condition (Backman, 1985; Backman & Nilsson, 1984, 1985; G. Cohen & Faulkner, 1989; Dick & Kean, 1989; Norris & West, 1988). This outcome was expected because this condition resembles traditional verbal recall tasks, such as word list recall, in which age differences are commonly observed (Kausler, 1982). The second hypothesis predicted that age differences would be observed in the verbal encoding/motor retrieval condition (Norris & West, 1988). This condition required subjects to translate verbally processed information into motor actions for recall. Young adults were expected to be advantaged in this condition because they are familiar with processing verbal information and spontaneously recoding this information into potential contextual cues which are not directly provided by the task. Older adults, on the other hand, were expected to be disadvantaged in this condition because they are less efficient at translating and transforming the verbal information. In contrast, the translation from motor encoding to verbal retrieval has not produced age differences in recall (Backman, 1985; Backman & Nilsson, 1984, 1985) perhaps because the young and old adults are both unfamiliar with processing lists of unrelated actions at encoding. The third hypothesis predicted that age differences in recall would be eliminated in the motor encoding/verbal retrieval condition (Backman, 1985; Backman & Nilsson, 1984, 1985; G. Cohen & Faulkner, 1989; Dick & Kean, 1989; Norris & West, 1988). Older adults were expected to perform at the same level as young adults in this condition because the motor encoding provides the subjects with multimodal cues. By processing these available multimodal cues, the older adults were expected to use the same cues for remembering as young adults. Finally, age differences were expected to be eliminated in the motor encoding/motor retrieval condition (Saltz, 1988). Older adults were expected to perform as well as young adults in this condition because contextual cues were provided during both the encoding and retrieval stages. It has been demonstrated that age differences in verbal recall are eliminated when cues are provided during both encoding and retrieval (Smith, 1977). A similar outcome was expected for the SPTs.

This study also compared recall of SPT items which could be organized into four semantic categories with SPT items which could not be organized in order to examine the influence of strategic processing on eliminating age differences in SPT recall. There is no previous SPT study which has examined age differences in organization when motor cues are varied during both encoding and retrieval. This study explored age differences in the organization of SPTs under those conditions which vary verbal and motor processing during both the encoding and retrieval stages. Previous SPT literature has compared clustering in the verbal encoding/verbal retrieval condition to clustering in the motor encoding/verbal retrieval condition. These results were mixed as indicated earlier. The additional conditions in this study (verbal encoding/motor retrieval and motor encoding/motor retrieval) have not been used previously. It was hypothesized that age differences in recall would be eliminated only in those conditions which also eliminated age differences in organization, suggesting that the lack of age differences in SPT recall may be related to strategic processing (Norris & West, 1988).

Method

Subjects

The subjects included 80 older adults (60-79 years, *M* = 68.7, *SD* = 4.9) and 80 young adults (18-26 years, *M* = 19.7, *SD* = 1.4). The older adults were recruited from the community by newspaper advertisement and solicitation at community organizations and senior citizen organizations and received $10.00 for their participation. The young adults were recruited from university classes and received course credit for their participation. The older and young adults did not differ in terms of education, $p > .05$ (older adult range = 8-21 years, *M* = 14.3, *SD* = 3.4; young adult range = 12-17, *M* = 13.5, *SD* = 1.0), or WAIS-R Information subtest scores, $p > .05$ (older adult range = 8-18, *M* = 12.1, *SD* = 2.3; young adult range = 6-17, *M* = 11.5, *SD* = 2.4). The older adults were screened for current health status to eliminate persons with cardiovascular disease or other chronic health problems that may affect memory performance (see Appendix A).

Materials

The SPT items were primarily obtained from R. L. Cohen's (1981) SPT item list (see Appendix B). In order to fulfill the requirements of variables tested in this experiment, additional SPT items were added to R. L. Cohen's original list.

Two 16-item lists were used to test recall. The items on one list could be organized into four semantic categories including movements with 1) hands, 2) legs, 3) face, and 4) torso. The items on the second list were also body movements, but the items did not represent distinct semantic categories. Pilot testing confirmed that seven out of ten subjects were able to identify all four categories in the organized list, whereas no subjects were able to identify consistent categories in the unorganized list.

Procedure

The design was a 4 x 2 x 2 mixed factorial in which there were two between subjects factors, test condition and age group, and one within subjects factor, list organization. The between-subjects factor included the following four test conditions: 1) verbal encoding/verbal retrieval, 2) verbal encoding/motor retrieval, 3) motor encoding/verbal retrieval, and 4) motor encoding/motor retrieval. Twenty subjects from each age group were randomly assigned to each condition. The following diagram illustrates the between subjects design used:

Verbal Encoding

Examiner reads SPT list	
Verbal recall	Motor recall
Verbal encoding/ Verbal retrieval	Verbal encoding/ Motor retrieval

Motor Encoding

Examiner reads SPT list as the subjects perform the SPTs	
Verbal recall	Motor recall
Verbal encoding/ Verbal retrieval	Verbal encoding/ Motor retrieval

The within-subjects factor, list organization, was examined by testing all subjects on recall of two lists, one which could be organized into four semantic categories and one which could not be organized into semantic categories.

Subjects were first given general instructions which were specific to the encoding and retrieval condition under which they were tested (see Appendix C). A practice task was then demonstrated to the subjects. The practice task was followed by the two SPT lists. The two SPT lists were part of a larger battery including two other SPT lists, the WAIS-R Information subtest, and a demographic questionnaire. SPT list order was counter-balanced such that each list was placed in a different position for each of four list orders. In order to reduce interference effects between lists, the Information subtest and the demographic questionnaire were administered following the second list.

The SPT items were read to all of the subjects at a rate of one item every six seconds. Subjects in the verbal encoding conditions were instructed only to listen to the items. Subjects in the motor encoding conditions were instructed to perform the actions specified by each SPT item as the items were read to them by the experimenter.

Immediate free recall was obtained after each list was presented. Verbal retrieval required written verbal recall of the items. Motor retrieval required a re-enactment of the SPT items.

Subjects in the motor retrieval conditions were videotaped in order to have a record of their performance to test for inter-rater reliability. The record sheet from the subjects in the verbal retrieval conditions was also available to test for inter-rater reliability.

Results

Twenty-one protocols were independently scored by two examiners. The scores obtained from the two examiners were within one point of each other on 95% of the protocols, and produced a correlation of .96. This indicates that the scoring method was highly reliable. The data analysis was conducted on the scores obtained by the primary investigator.

For both age groups there were no significant differences in the recall of items obtained from R. L. Cohen's (1981) list and the new SPT items which were added to fulfill the experimental requirements, $p > .05$ (p-value corrected for two t-tests).

The repeated measures analysis was a 2 (age) x 4 (test condition) x 2 (list organization) x 4 (list order) mixed factorial in which age, test condition, and list order were between-subject factors and list organization was a within-subjects factor. All apriori comparisons were conducted with Tukey's test ($p < .05$).

There were significant main effects for age group, $F(1, 128) = 53.83$, $p < .0001$, $w^2 = .21$; condition, $F(3, 128) = 14.10$, $p < .0001$, $w^2 = .16$; and organization, $F(1, 152) = 24.10$, $p < .0001$, $w^2 = .11$ (see Table 1-1). The age by condition interaction was not significant. Young adults recalled more than older adults. The verbal encoding/verbal retrieval condition produced significantly less recall than all other conditions. Finally, more items were recalled on the organized list than the unorganized list.

Main effects for list order were not significant; however, the order by condition by list interaction was significant, $F(9, 128) = 2.07$, $p < .05$, $w^2 = .01$. Posthoc tests using Scheffe's ($p < .05$) showed that condition differences varied as a function of list and order. In every case, recall was significantly lower in the verbal/verbal condition than the other three conditions. In addition, list differences varied as a function of condition and order. The organized list was recalled at a higher rate than the unorganized list only under some order and condition combinations. No clear pattern emerged.

The group by list organization interaction was also significant, $\underline{F}(1,152) = 8.23$, $\underline{p} < .005$, $\underline{w}^2 = .04$. For the older adults, more items were recalled on the organized list than on the unorganized list; however, there was no organization effect for young adults (see Figure 1-1).

Apriori analyses of the hypotheses concerning conditions produced the following results: young adults recalled significantly more than the older adults in the verbal/verbal condition, $\underline{F}(1,152) = 13.97$, $\underline{p} < .005$ and the motor/verbal condition $\underline{F}(1,152) = 9.41$, $\underline{p} < .005$. Age differences in recall were not significant in the verbal/motor and the motor/motor conditions (see Figure 1-2). This confirmed the hypotheses that age differences in recall would remain in the verbal/verbal condition and age differences would be eliminated in the motor/motor condition. The hypotheses concerning the verbal/motor and motor/verbal conditions were not confirmed.

In order to investigate the role of encoding and retrieval cues on the elimination of age differences, the data were collapsed in order to compare verbal and motor encoding, as well as verbal and motor retrieval as a function of age. Encoding effects were examined by combining the verbal/verbal and verbal/motor conditions into one verbal encoding condition, and this was compared to the motor encoding condition which was the combined motor/verbal and motor/motor conditions. Likewise, verbal retrieval (the combined verbal/verbal and the motor/verbal conditions) were compared to motor retrieval (the combined verbal/motor and the motor/motor conditions) to analyze retrieval effects. The group by retrieval interaction was significant, $F(1,152) = 4.29$, $p < .05$, $w^2 = .01$. For older adults, posthoc comparisons showed that more items were recalled with motor retrieval than with verbal retrieval; however, there was no retrieval effect for young adults. The group by encoding interaction was not significant.

The data from the organized list were also analyzed using ARC clustering scores as the dependent measure to observe organization effects. The ARC measure was chosen because it is does not vary with the number of items or categories recalled (Roenker, Thompson, & Brown, 1971). Main effects for group and condition, as well as their interaction, were not significant. In all four conditions, age differences in the ARC clustering score were not significant. In contrast, age differences in recall were eliminated in only the verbal/motor and the motor/motor conditions, $p < .005$. Due to very large standard deviations in ARC scores ($M = .23$, $SD = .34$), the data was analyzed again using an arcsine transformation of the ARC scores. This produced the same results as above. The hypothesis that age differences in recall would be eliminated in those conditions which also eliminated age differences in organization was not supported; however, interpretation of the data is made with caution due to the large variability in ARC scores. Large standard deviations for ARC scores were also reported by Lichty et al. (1986).

Because of the limited usefulness of the ARC scores, post hoc analyses with Scheffe's test ($p < .05$) were conducted to compare age differences in recall as a function of list organization and test conditions. Age differences in recall of the organized list were eliminated in the three conditions with motor cues: verbal/motor, motor/verbal, and motor/motor. There were significant age differences in recall only in the verbal/verbal condition. In contrast, for the unorganized list, there were significant age differences in the verbal/verbal, verbal/motor, and motor/verbal conditions. There were no age differences in recall of the unorganized list only in the motor/motor condition. This comparison suggests that the combination of organization and motor cues was important in eliminating age differences in SPT recall. Age differences in the recall of an organizaed list were eliminated when motor cues were available during either encoding or retrieval.

A serial position analysis was also performed in order to examine the influence of rehearsal on SPT recall (see Figures 1-3 to 1-6). Consistent with other SPT studies, there was a distinct primacy effect in the verbal/verbal condition in contrast to the absence of a primacy effect in the motor/verbal condition (Backman & Nilsson, 1984; 1985; R. L. Cohen, 1981). Serial position effects were also analyzed in conditions which have not yet been investigated in the literature: verbal/motor and motor/motor. In addition to the motor/verbal condition, the primacy effect was also reduced in the motor/motor condition.

The data also produced unexpected results in terms of recency effects. There was an absence of recency effects in both the verbal/motor and the motor/motor conditions. Together, these results suggest that motor encoding reduces primacy effects and motor retrieval reduces recency effects relative to those observed in the corresponding verbal conditions.

The serial position analyses were very consistent across age groups. Both older and young adults showed the same pattern of an absence of primacy effects with motor encoding and an absence of recency effects with motor retrieval. This suggests that individual item characteristics and the specific encoding and retrieval conditions influenced the serial position curves for both ages.

Discussion

Geropsychologists have attributed the age-related decline in memory to encoding and retrieval deficits in the elderly (Kausler, 1982), and their differential influence has been debated (Poon, Walsh-Sweeney, & Fozard, 1980). In this study, the manipulation of motor cues at both stages of processing resulted in an elimination of age differences when motor cues were provided during retrieval, while an age deficit in recall remained when motor cues were provided only during encoding. These results lend support to the notion that older adults do not spontaneously generate retrieval cues, and indicated that older adults can bring their recall performance up to the level of young adults when the task provides motor cues during retrieval. Further support for the retrieval deficit hypothesis comes from another study in which an age deficit occurred in recall but not for recognition of SPTs (Knopf & Neidhardt, 1989).

It has been argued that the reinstatement of internal and external contextual information during recall can compensate for older adults' retrieval deficits, thus eliminating age differences in recall (Burke & Light, 1981). Hence, age differences in recall may be eliminated in the verbal/motor and motor/motor conditions because the motor enactment at retrieval elicits contextual information which was processed during encoding either in terms of internal images of enactment or via the enactment itself. Kausler and Lichty (1988) have also argued that the age deficit which is sometimes found in activity memory is a result of older adults' deficit in retrieving contextual information at recall. When contextual cues are provided at retrieval, as occurs with motor retrieval, older adults improve their level of recall. Unlike young adults, older adults must rely on contextual cuing at retrieval. In contrast to the motor retrieval conditions, age differences in the motor/verbal condition are seen because the nonverbal contextual information which was processed during encoding is of no benefit for the older adults when they are faced with a verbal recall task.

Many previous studies have found that age differences in SPT recall are eliminated in the motor/verbal condition (Backman, 1985; Backman & Nilsson, 1984, 1985; G. Cohen & Faulkner, 1989; Dick &

Kean, 1989). This finding was not replicated in this study. Other experimenters have also found significant age differences in SPT recall with the motor/verbal condition (R. L. Cohen, Sandler, & Schroeder, 1987; Craik, 1989; Knopf & Neidhardt, 1989; Nilsson & Backman, 1989; Guttentag & Hunt, 1988; Lichty et al., 1986). Several explanations have been offered to account for these discrepant findings including item characteristics, the use of objects, and list characteristics (Norris & West, in press).

The magnitude of age differences can vary greatly from item to item (Kausler & Lichty, 1988). As noted in a recent review, age differences in recall were significant in approximately 15% of the items (Kausler & Lichty, 1988). The age differences were not significant for the remaining items, and on several items, the older adults recalled more than the young adults. The present study also suggests that there may be important item characteristics which predict the magnitude of age differences in recall. Age differences in recall were significant for 34% of the items, and the older adults occasionally recalled items at a higher rate than young adults (see Table 1-2). This data clearly points out that age differences in recall vary substantially from item to item. Further exploratory work is needed to identify item characteristics which predict age differences in recall. Possible item characteristics which may influence the magnitude of age differences include item familiarity, vividness, distinctiveness, complexity of movement, and others.

Earlier studies have investigated some of these variables that may reflect item characteristics predictive of SPT recall in young adults. Familiarity and vividness did not predict recall (R. L. Cohen, Peterson, & Mantini-Atkinson, 1987; Knopf & Neidhardt 1989). On the other hand, there is also data which suggests that the goal of the action rather than the kinesthetic cue is more important in predicting recall. That is, the movement sequence (e.g. a circular hand motion) is less predictive of recall than the action goal (e.g. drawing a circle) (R. L. Cohen & Heath, 1988). This implies that item recallability is less influenced by sensory information such as kinesthetic cues than by variables related to the meaningfulness of the action. These variables might concern how frequently items are typically performed, how easy they are to imagine, how simple versus complex they are, and other predictive variables of item recallability.

These earlier studies have laid a foundation for identifying item characteristics that influence SPT recall; however, they do not address the variability of the magnitude of age differences across items. Research is still needed in order to identify item characteristics that affect the pattern of age differences. In the verbal memory literature, experimental control has been maintained over variables such as word frequency and concreteness. During word list acquisition, subjects are accurate in predicting which items will be subsequently recalled; whereas subjects (and presumably experimenters) are highly inaccurate in predicting recall of SPTs (R. L. Cohen, 1988). Further research in this area may shed light on those item characteristics which predict SPT recall, and more specifically, those item characteristics and stimulus properties which enhance the memory performance of older adults, and hence, eliminate age differences in recall.

Perhaps item characteristics which predict age differences in recall are important in terms of their value for cuing during retrieval. Kausler and Hakami (1983) argue that the retrievability of memory traces varies directly with the distinctiveness of those traces. Hence, age differences in activity recall will be greater for those items which are not highly distinctive because older adults will have greater difficulty in retrieving those items. Presumably, motor retrieval cues, as well as other yet unknown item characteristics, provide distinctive contextual information which aids older adults at retrieval.

It has also been suggested that age differences in SPT recall may be predicted by list characteristics such as organization. The hypothesis that age differences in recall would be eliminated only in those conditions which also eliminated age differences in organization could not be sufficiently addressed because of large variability in ARC scores. However, support for the organization hypothesis came from the observed list by group interaction. Older adults obtained a higher level of recall on the organized list than the unorganized list; whereas there was no organization effect for young adults. It appears that age differences in SPT recall were related to list organization. Age differences were eliminated in the recall of an organized SPT list when motor cues were provided either during encoding or retrieval. Organization cues in SPT recall appear to differentially benefit older adults. In contrast, age differences were found in the recall of an unorganized SPT list except when motor cues were provided at both encoding and retrieval. This suggests that older adults perform poorly on SPT recall when list items can not be readily organized unless the task provides cues during retrieval which were also provided during encoding. As has been observed in the verbal memory literature, minimal age differences are seen when cues are provided at both encoding and retrieval (Poon, 1985).

Another variable which has been reviewed in the aging literature concerns the use of objects in the performance of the task items (Norris & West, in press). SPT studies which have not found significant age differences in recall in the motor/verbal condition have typically used lists in which some, if not all, items required the use of objects (Backman & Nilsson, 1984, 1985; Dick & Kean, 1989; G. Cohen & Faulkner, 1989). No items in the present study required the use of objects. It is possible that age differences in SPT recall were magnified because the lists did not include object cues. Those studies in which age differences in SPT recall were found included lists in which all items required the use of objects (Lichty et al., 1986), lists in which only some items required the use of objects (R. L. Cohen, Sandler, & Schroeder, 1987), and lists in which no items used objects (Guttentag & Hunt, 1988; Knopf & Neidhardt, 1989). It is likely that the presence of objects interacts with other important effects such as rate of presentation (see Experiment #3). Perhaps object cues, in interaction with other variables, are particularly important in predicting age differences in the motor/verbal condition because the objects are processed during encoding, but do not serve as cues during retrieval. It is possible that age differences in the motor/verbal condition used here were increased because there were no cues provided by the objects during encoding. This issue will be addressed in Experiment 2.

Finally, the manipulation of motor cues during both encoding and retrieval produced interesting results concerning serial position. Primacy effects were eliminated when items were motorically encoded, and recency effects were reduced when items were motorically retrieved. This pattern was evident for both young and older adults. It has been argued that primacy effects are not found in SPT recall because SPT recall is nonstrategic with respect to rehearsal (R. L. Cohen, 1981). The absence of rehearsal for both young and older adults may be a partial explanation for why age differences are sometimes eliminated in SPT recall. Age differences in verbal recall have been attributed to young adults' spontaneous use of strategies such as rehearsal (Hultsch & Deutsch, 1981). Contrary to verbal recall tasks, in SPT recall young adults do not appear to use rehearsal to a greater extent than older adults. Hence, age differences in SPT recall may be reduced in some cases because young adults are not making greater use of rehearsal in SPT recall than older adults.

The negative recency effect observed with motor retrieval was unexpected. Two possible explanations may be considered. First, it is possible that a recency effect is not seen with motor retrieval because the re-enactment of other items serve as interference, thus reducing recall of the terminal items on the list.

Interference effects from competing motor acts have been observed with the motor re-enactment of sentences (Zimmer & Engelkamp, 1985; Saltz & Donnenworth-Nolan, 1981). This explanation is tenuous. A recency effect results from recalling the last items on the list first. Hence, there are no intervening items to create an interference effect. Alternatively, it has been argued that recency effects are due to a highly accessible verbal memory trace (R. L. Cohen, 1981). Atkinson and Shiffrin (1968) have also stressed the verbal nature of short-term store. Hence, motor retrieval may not produce recency effects because the action recalled is not strongly influenced by a verbal memory trace.

The serial position analysis underscores the notion that verbal recall tasks and motor recall tasks are governed by different memory laws. A comparison of the serial position results from the verbally processed information (i.e. the verbal/verbal condition) and the motorically processed information (i.e. the motor/motor condition) illustrates that recall of motorically processed items is not influenced by item position. When items are enacted at both encoding and retrieval a jagged serial position graph is produced, suggesting that some items have greater recall probability than other items, regardless of their positions on the list. This supports the notion that there are important item characteristics which predict recall of motorically processed information.

In conclusion, this study suggests that age-related memory declines may not be pervasive. Age differences in SPT recall were eliminated when motor cues were provided during retrieval. However, the influence of motor retrieval cues does not stand in isolation. The benefits of organization cues may be enhanced by motor processing, or may be reduced when object cues are absent during encoding. Furthermore, the magnitude of age differences in recall is item-dependent. Individual action items vary along numerous dimensions including the number and kind of body movements required, the types of multimodal cuing, the familiarity of the goal of the action, and so forth. These dimensions may together predict the distinctiveness of individual items which may in turn predict the retrievability of the memory trace. The relevant stimulus properties are not the same for word recall and SPT recall. More systematic analysis of item characteristics that predict age differences in SPT recall are needed.

Table 1-1

Means (and Standard Deviations) for Number of Items Recalled

Group (32[a])	
Younger	Older
21.1 (3.6)	17.1 (3.9)

Condition (32[a])			
Verbal/Verbal	Verbal/Motor	Motor/Verbal	Motor/Motor
16.1 (4.7)	19.8 (3.5)	20.7 (4.0)	19.8 (3.4)

Organization (16[a])	
Organized list	Unorganized list
10.0 (2.3)	9.2 (2.5)

Note. [a] Maximum Possible Score
For each main effect, differences were significant at $p < .0001$

Table 1-2

Percent of Young and Older Subjects Recalling Items

Organized List

Item	Young	Old	Difference
Snap your fingers	87	60	27*
Cross your legs	87	87	0
Blow in the air	52	34	18*
Lean to the left	92	74	18*
Tap your foot	62	57	5
Stick out your tongue	46	44	2
Tilt back in chair	71	64	7
Clasp your hands together	69	56	13
Bend forward at the waist	73	70	3
Raise one leg	53	44	9
Count finger on hand	37	34	3
Laugh	74	54	20*
Stretch your legs	73	66	7
Shrug your shoulders	41	43	-2
Cross your fingers	69	56	13
Yawn	89	87	2

Unorganized List

Item	Young	Old	Difference
Shake head back and forth	69	52	17*
Pretend to be asleep	62	37	25*
Name street you live on	79	56	23*
Knock on the table	74	55	19*
Clap your hands	36	22	14
Cup hand over ear	59	51	8
Name four colors	72	37	35*
Point to your mouth	44	25	19*
Pretend to play the piano	37	30	7
Nudge arm of the chair	85	72	13
Clear your throat	49	34	15
Scratch your nose	73	84	-11
Smooth your hair	77	67	10
Blink three times	74	62	12
Flex your arm	81	60	20*
Wave good-bye	71	65	6

Note. *$p < .05$, chi-square test.

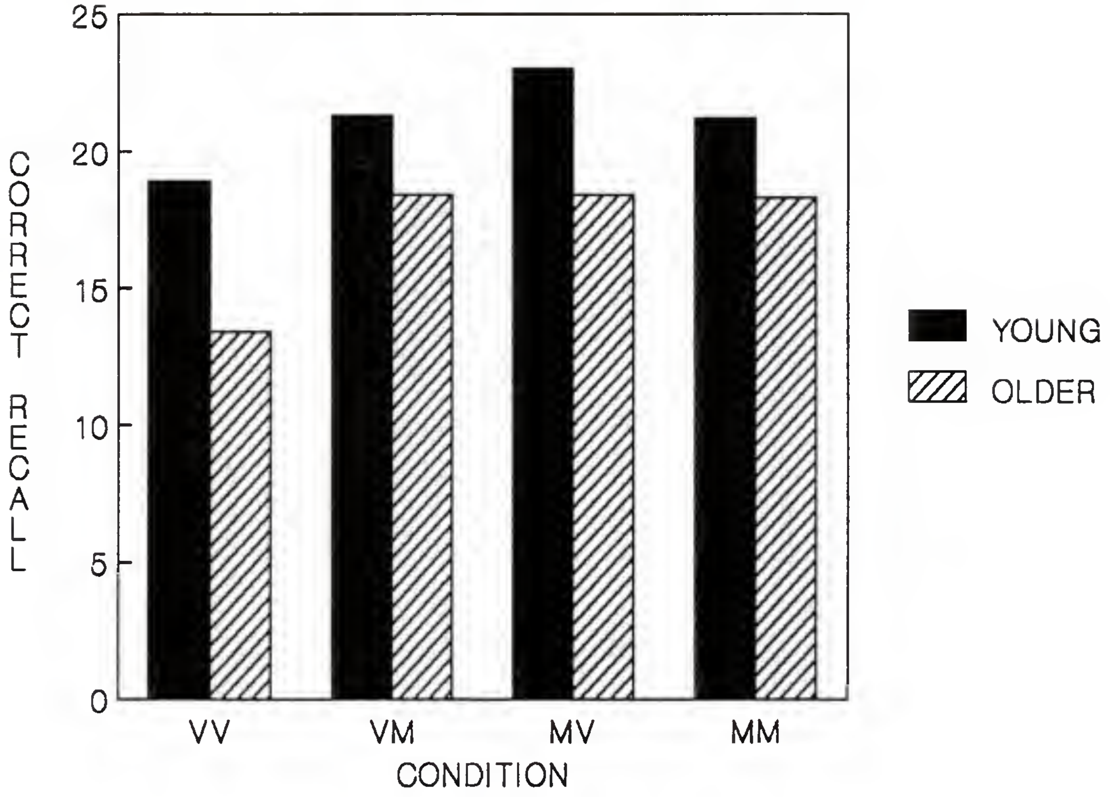

Figure 1-1: Recall by Age and Condition

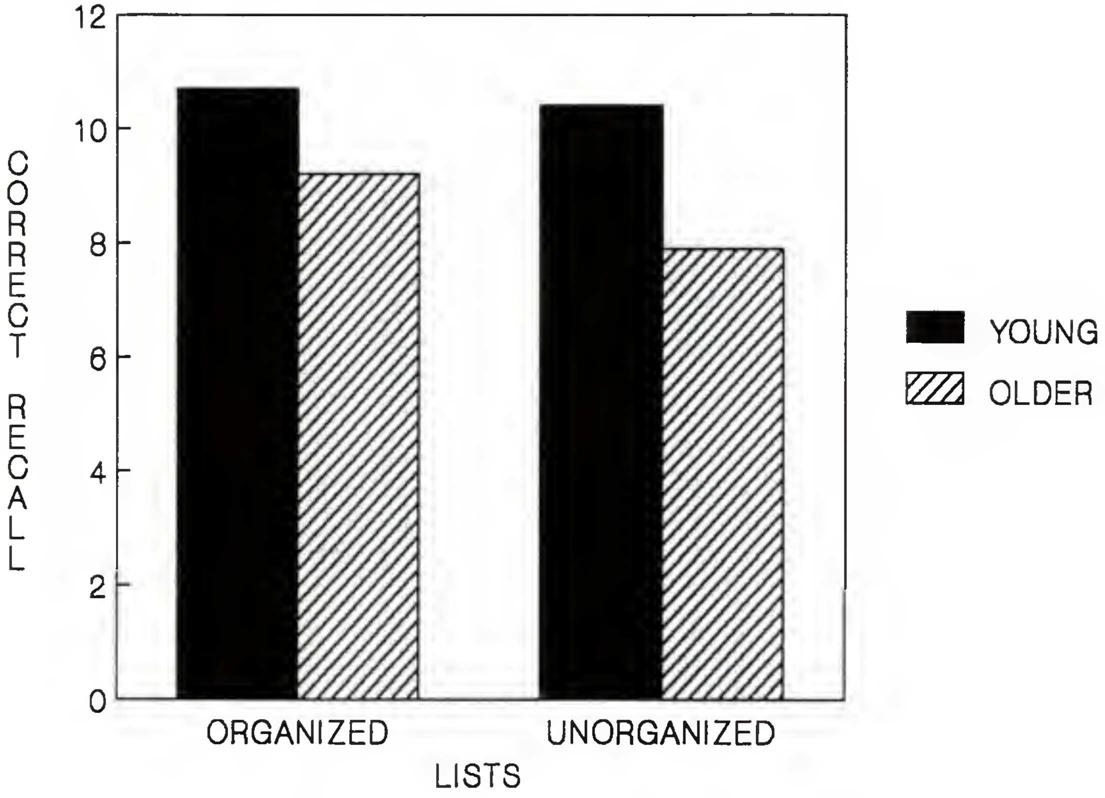

Figure 1-2: Recall by Age and Organization (Exp 1)

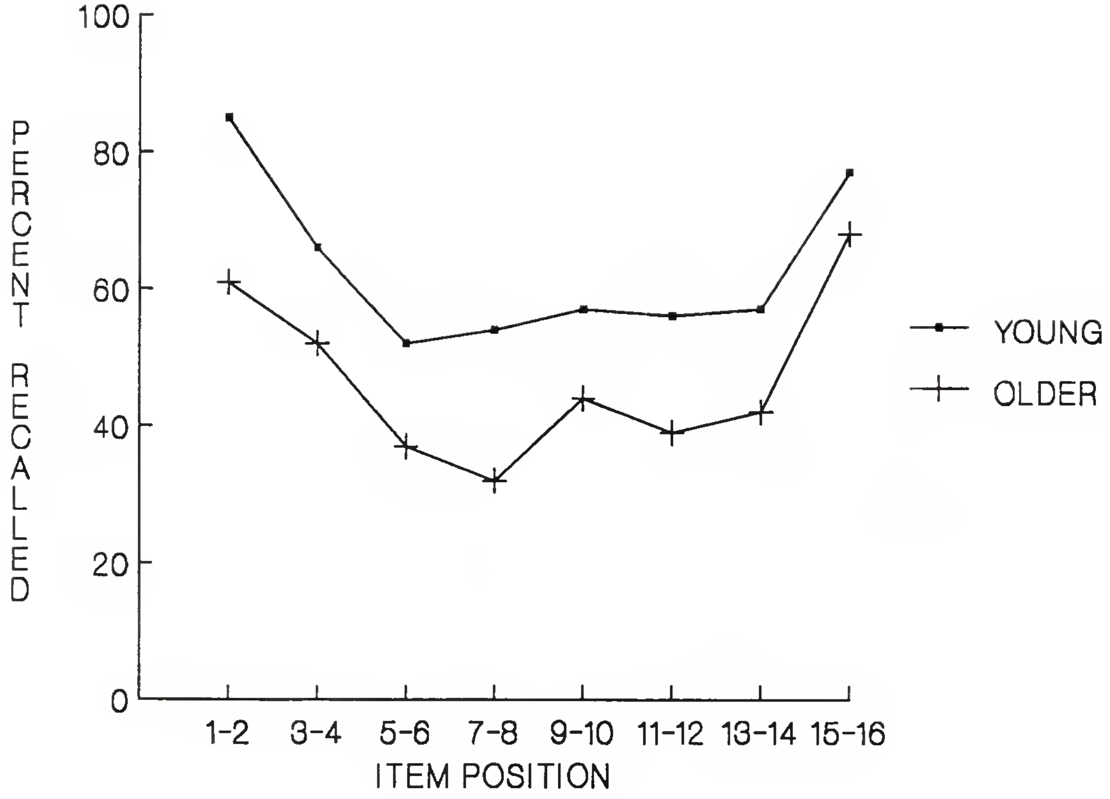

Figure 1-3: Serial Position--Verbal/Verbal

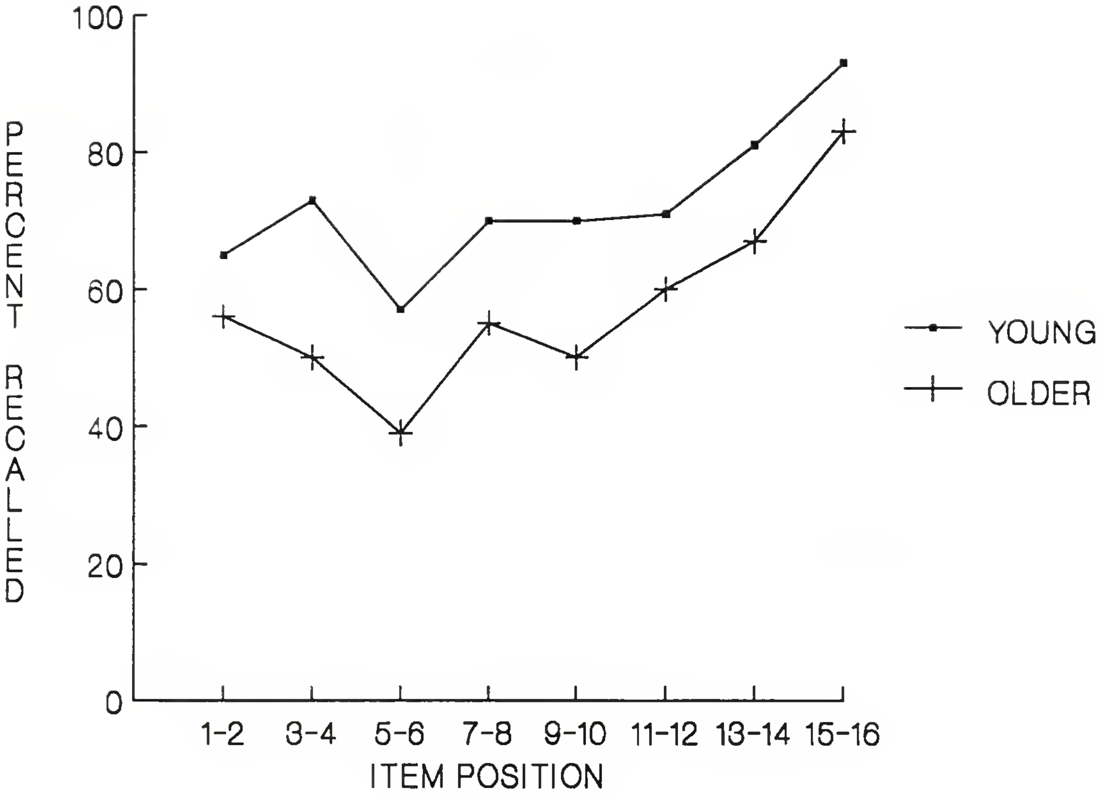

Figure 1-4: Serial Position--Motor/Verbal

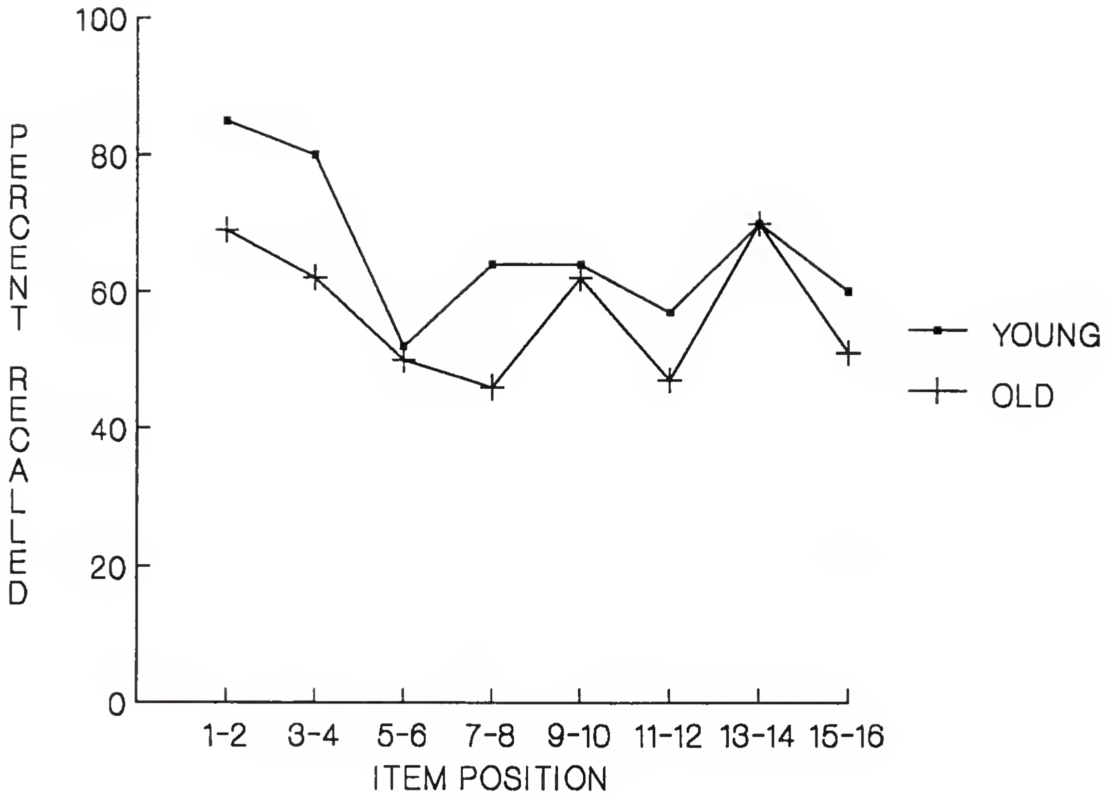

Figure 1-5: Serial Position--Verbal/Motor

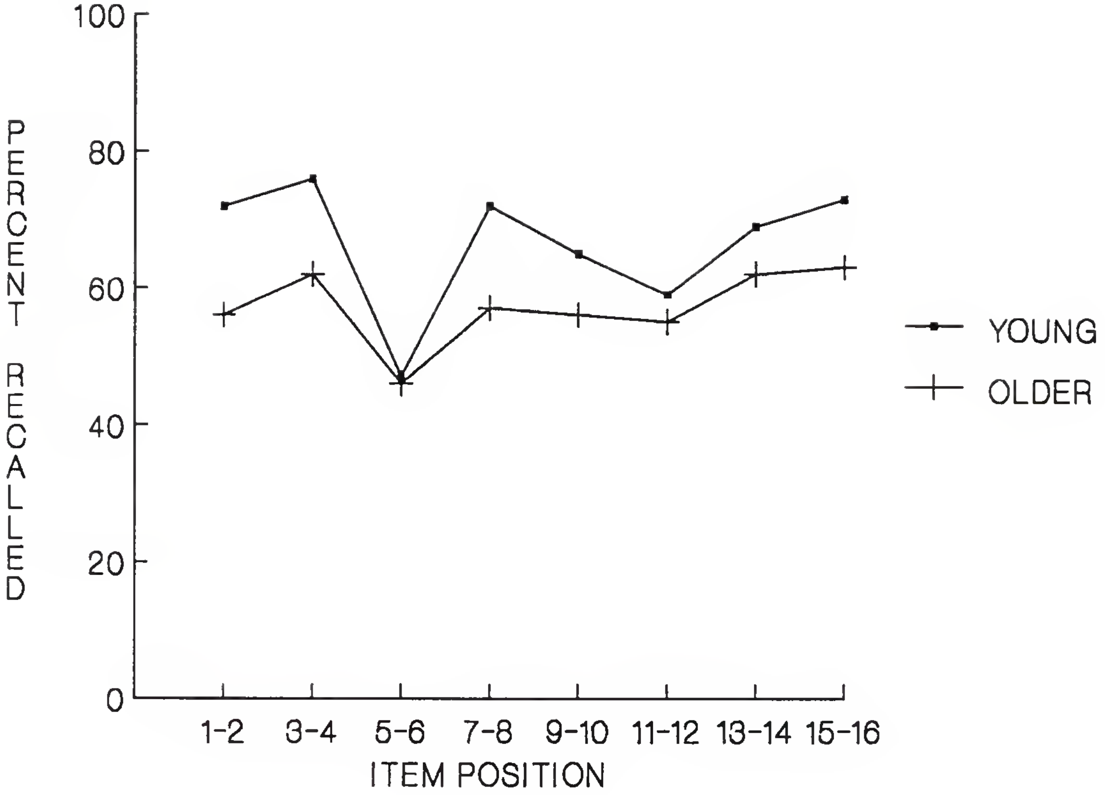

Figure 1-6: Serial Position--Motor/Motor

EXPERIMENT 2

Introduction

Age differences in the recall of SPTs have often been eliminated in studies in which all, or most, list items required the use of an object (Backman, 1985; Backman & Nilsson, 1984, 1985; Dick & Kean, 1989). In contrast, age differences in SPT recall have been found when few or no items required the use of an object (R. L. Cohen, Sandler, & Schroeder, 1987; Guttentag & Hunt, 1988; Knopf & Neidhardt, 1989). It is possible that age differences in SPT recall were not eliminated in Experiment 1 because no items required the use of objects.

It has been argued that age differences in SPT recall are eliminated because SPTs involve multiple sensory stores including visual, auditory, motor, and tactual (Backman & Nilsson, 1984, 1985). It is possible that motor cues alone are not sufficient to eliminate age differences in recall. These multimodal properties of SPTs, often present when objects are used, may be as important as motor cues per se in eliminating age differences in recall. An age deficit may be found in SPT recall when no objects are used to carry out the actions because fewer stimulus properties are provided.

The multimodal hypothesis suggests that the combination of visual and motor cues are necessary to eliminate age differences in SPT recall. Evidence for the multimodal hypothesis comes from studies that demonstrate that neither motor cues nor object cues alone are sufficient to eliminate age differences in activity memory. Young adults recalled significantly more performed actions than older adults when no objects were used (e.g., items like "shake your head yes" were used), suggesting that motor cues alone do not eliminate age differences in SPT recall (Guttentag & Hunt, 1988; Knopf & Neidhardt, 1989). In addition, there is evidence that object cues alone are insufficient to bring older adults' recall up to the level of young adults. Young adults recalled more than older adults when SPTs were presented in the form of sentences with objects present, thereby eliminating the motor cues (Backman, 1985). Furthermore, age differences in recall have also been found when subjects watched the experimenter perform the task, thereby providing visual but not motor cues (Dick &

Kean, 1989). These studies suggest that motor cues or object cues alone are not sufficient to eliminate age differences in SPT recall. Older adults may perform as well as young adults only when there are multiple cues available.

The role of objects in SPT recall has been investigated, but not as a function of age. In most studies, no differences in recall have been found when comparing SPT items with objects and items without objects (Backman & Nilsson, 1984; R. L. Cohen, 1988; R. L. Cohen, Peterson, & Mantini-Atkinson, 1987, Experiment 1). Other data showed that objects improved recall (Helstrup, 1986, 1987). It has been argued that objects may improve recall because of the contextual cue the objects provide (Backman & Nilsson, 1984, 1985). On the other hand, other data showed that items without objects yielded better recall than items with objects (R. L. Cohen, Peterson, & Mantini-Atkinson, 1987, Experiment 2). They argue that unlike items that use objects, items without objects may be recalled at a higher rate because those items provide environmental cues during retrieval such as one's hands in the item "clap your hands". However, the above studies looked only at a young adult sample or collapsed the data over age groups, and therefore, do not address the question of whether the combination of motor and visual cues accounts for the elimination of age differences in SPT recall.

The age deficit in SPT recall obtained in Experiment 1 may have resulted from the use of items which did not require objects. In this experiment, the use of objects was varied across lists in order to determine if age differences in SPT recall would be eliminated when both motor and visual cues were present during encoding, as would be suggested by the multimodal hypothesis.

Experiment 1 also provided results concerning the role of organization in SPT recall which were worthy of further exploration. Age differences in the recall of an organized SPT list were eliminated in all conditions with motor cues. Compelling differences also appeared from the item analysis. Forty-four percent of the items from the unorganized list showed age differences in recall, in contrast to only 25% of the items from the organized list. It was concluded that age differences in SPT recall may be predicted to a large degree by list organization. This finding suggested that it was worthwhile to manipulate list organization again to try to replicate these findings.

This study examined the effects of object cues and list organization on age differences in SPT recall. The following four lists were presented: 1) organized list with objects present, 2) unorganized list with objects present, 3) organized list without objects, and 4) unorganized list without objects. These lists were varied under two conditions--verbal/verbal and motor/verbal--the conditions commonly included in most studies of SPTs and aging. Pilot testing indicated that the presence of objects during motor retrieval resulted in significant ceiling effects for both age groups. Hence, it was not useful to examine motor retrieval in this experiment.

According to the multimodal hypothesis, the age deficit in SPT recall which was found in Experiment 1 may have been due to the absence of objects. Without objects, there may not have been enough cues for the older adults. This study compared recall of SPTs that required the use of an object (e.g. "push the toy car") to recall of SPTs with no objects present (e.g. "shrug your shoulders") in order to examine the role of object cues in eliminating age differences in SPT recall. It was hypothesized that age differences would be found in the verbal encoding/verbal retrieval condition regardless of the presence of objects. This outcome was expected because previous literature has found that object cues are not sufficient to eliminate age differences in recall with the verbal encoding/verbal retrieval condition (Backman, 1985). It was also hypothesized that age differences would be eliminated in the motor encoding/verbal retrieval condition when objects are present. According to the multimodal hypothesis, the combination of motor and visual cues will eliminate age differences in SPT recall because this condition provides older adults with multiple cues (Backman & Nilsson; 1984, 1985). By processing these motor and object cues, the older adults are expected to use the same cues for remembering as the young adults.

It was also hypothesized that in the motor/verbal condition age differences would be eliminated in the recall of organized lists and age differences would remain in the recall of the unorganized lists. Replication of Experiment 1 would support the supposition that list organization is an important predictor of age differences in SPT recall.

Method

Subjects

The subjects included 80 older adults (60-79 years, M = 68.7, SD = 4.9) and 80 young adults (18-26 years, M = 19.7, SD = 1.4). The older adults were recruited from the community by newspaper advertisement and solicitation at community organizations and senior citizen organizations and received $10.00 for their participation. The young adults were recruited from university classes and received course credit for their participation. The older and young adults did not differ in terms of education, $p > .05$ (older adult range = 8-21 years, M = 14.3, SD = 3.4; young adult range = 12-17, M = 13.5, SD = 1.0), or WAIS-R Information subtest scores, $p > .05$ (older adult range = 8-18, M = 12.1, SD = 2.3; young adult range = 6-17, M = 11.5, SD = 2.4). The older adults were screened for current health status to eliminate persons with cardiovascular disease or other chronic health problems that may affect memory performance (see Appendix A).

Materials

The SPT items were primarily obtained from R. L. Cohen's (1981) SPT item list (see Appendix D). In order to fulfill the requirements of the variables tested in this experiment, additional SPT items were added to R. L. Cohen's original list.

Four 16-item lists were used to test recall: 1) organized list with objects present (categories included actions with office, kitchen, toiletry, and sewing items), 2) unorganized list with objects present (all objects were toys), 3) organized list without objects (categories included actions with hand, feet, torso, and mouth), and 4) unorganized list without objects. Pilot testing confirmed that seven out of ten subjects were able to identify all four semantic categories in the two organized lists, whereas no subjects were able to identify consistent categories in the unorganized list.

Procedure

The design was a 2 x 2 x 2 x 2 mixed factorial in which there were two between-subjects factors, test condition and age group, and two within-subjects factors, presence of objects and list organization. The between-subjects factor included the following two test conditions: 1) verbal encoding/verbal retrieval, and 2) motor encoding/verbal retrieval. Twenty subjects from each age group were randomly assigned to each condition. The within subjects factors included presence of objects (objects present or not) and list organization (organized or unorganized list).

Subjects were first given general instructions which were specific to the condition in which they were tested (see Appendix C). A practice task was then demonstrated to the subjects. The practice task was followed by the four SPT lists. SPT list order was counter-balanced such that each list was placed in a different position for each of four list orders. In order to reduce interference effects between lists, the WAIS-R Information subtest and a demographic questionnaire were administered following the second list.

The SPT items were read to subjects at a rate of one item every six seconds. Subjects in the verbal encoding/verbal retrieval condition were instructed only to listen to the items. Subjects in the motor encoding/verbal retrieval condition were instructed to perform the actions specified by each SPT item as the items were read to them by the experimenter. Participants had no difficulty carrying out these simple actions in the time allotted.

The objects were presented on a table for the two lists that required the use of objects. All objects plus 16 distractor items were present during presentation of the entire list. The objects were covered during recall.

Immediate free recall was obtained after each list was presented. All subjects were tested for verbal retrieval which required written verbal recall of the items.

Results

Twenty-one protocols were independently scored by two examiners. The scores obtained from the two examiners were within one point of each other on 97% of the test protocols, and produced a correlation of .96. This indicates that the scoring method was highly reliable. The data analysis was conducted on the scores obtained by the primary investigator.

On the organized list with objects, there were significant differences in the recall of items obtained from R. L. Cohen's list and the new SPT items which were added to fulfill the experimental requirements, $p < .005$. Both young and older adults recalled new SPT items at a higher rate than items from R. L. Cohen's list, $p < .05$ (p-value corrected for two t-tests). The new SPT items included all items from the kitchen and toiletry categories. The original SPT items included items from the sewing and office categories. The lower recall of Cohen's original SPT items may have been due to less familiarity with actions on his list.

The repeated measures analysis was a 2 (age) x 2 (test condition) x 2 (presence of objects) x 2 (list organization) x 4 (list order) mixed factorial in which age, test condition, and list order were between-subject factors and presence of objects and list organization were within-subject factors. Order effects were not significant and did not interact with any other factors, so order was dropped from the analyses reported here. All apriori comparisons were conducted with Tukey's test ($\underline{p} < .05$).

There were significant main effects for age group, $\underline{F}(1, 76) = 51.74$, $\underline{p} < .0001$, $\underline{w}^2 = .32$; condition, $\underline{F}(1, 76) = 26.95$, $\underline{p} < .0001$, $\underline{w}^2 = .17$; and presence of objects, $\underline{F}(1, 76) = 13.06$, $\underline{p} < .001$, $\underline{w}^2 = .12$ (see Table 2-1). Young adults recalled more than older adults. The motor encoding/verbal retrieval condition produced significantly greater recall than the verbal encoding/verbal retrieval condition. Items with objects were recalled at a higher rate than items without objects.

In addition, the following interactions were significant: age group by list organization, $\underline{F}(1, 76) = 4.99$, $\underline{p} < .05$, $\underline{w}^2 = .05$; object by condition, $\underline{F}(1, 76) = 7.32$, $\underline{p} < .01$, $\underline{w}^2 = .06$; and object by list organization, $\underline{F}(1, 76) = 17.71$, $\underline{p} < .0001$, $\underline{w}^2 = .17$. The age by list organization was due to older adults recalling more items on the organized lists than on the unorganized lists; however, there was no organization effect for young adults (see Figure 2-1). This replicates the age by list organization finding in Experiment 1. The object by condition interaction was due to greater recall of items with objects than items without objects in the verbal/verbal condition; whereas there was no object effect in the motor/verbal condition. The object by list organization interaction was due to greater recall of items with objects than items without objects on the unorganized lists; whereas there was no object effect on the organized lists. These interactions suggest that the impact of object cues is greater when other cues, such as motor cues and categories are not present.

Apriori analyses of the hypotheses concerning conditions showed that there were significant age differences in the verbal/verbal condition, $\underline{F}(1,76) = 6.96$, $\underline{p} < .05$; and the motor/verbal condition, $\underline{F}(1,76) = 5.98$, $\underline{p} < .05$. Contrary to the multimodal hypothesis, in the motor/verbal condition, young adults recalled more than older adults on both lists with object cues.

Apriori analyses of the hypotheses concerning list organization showed that age differences were eliminated in recall of the organized list without objects in the motor/verbal condition and the organized list with objects in the verbal/verbal condition. There were significant age differences in recall of the unorganized lists irrespective of presence of objects or test condition.

The data from the organized list were also analyzed using ARC clustering scores as the dependent measure to observe organization effects. Main effects for group and condition, as well as their interaction, were not significant. As was found in Experiment 1, large standard deviations restricted the interpretation of these results.

Discussion

The multimodal hypothesis was not supported in this study. Age differences in the recall of SPTs were not eliminated when items required the use of objects. The role of objects in recall was clarified, at least in part, by the interaction of objects with test condition and list organization. Object cues improved recall in the absence of other cues, but not when other cues, such as organization and motor cues are present. Object cues appeared to be less powerful than motor or organizational cues. Object cues did not eliminate age differences in SPT recall possibly because they are less powerful.

Previous studies have not found an age deficit in SPT recall when object cues were present during encoding (Backman, 1985; Backman & Nilsson, 1984, 1985; Dick & Kean, 1989). One possible explanation for these discrepant findings concerns the presentation of objects during list learning. In previous studies, each object was handed to the subjects as the corresponding task instructions was read and the object was removed from the subject's view immediately following the action. In this study, all objects were in view during presentation of the entire list. This may have enhanced rehearsal because the presence of the objects would bring to mind the earlier items during the presentation of the entire list. Alternatively, the procedure used in this study may have allowed for less time to encode individual items because of the time required to scan the table for the required object. Although this was minimized by the examiner pointing to each object as the related item was read, it is possible that older adults were penalized by this procedure because they did not have sufficient time to encode the information effectively.

Other explanations are needed to address the discrepant findings in the literature. An increasing number of investigations are failing to find that age differences are eliminated in SPT recall (R. L. Cohen, Sandler & Schroeder, 1987; Guttentag & Hunt, 1988; Knopf & Neidhardt, 1989), including studies which used objects (Craik, 1989; Nilsson & Backman, 1989). Numerous explanations have been offered to explain the discrepancy including list length, retrieval interval, and item familiarity (Knopf & Neidhardt, 1989; Norris & West, in press). However, the contradictory findings remain unexplained. Two additional considerations may offer some clarity. Six to eight lists were used in those studies which found no age differences in SPT recall (Backman, 1985; Backman & Nilsson, 1984, 1985; Dick & Kean, 1989). In contrast, only one to four lists have been used in studies in which age differences in SPT recall were found (R. L. Cohen, Sandler, & Schroeder, 1987; Guttentag & Hunt, 1988; Knopf & Neidhardt, 1989; Lichty et al., 1986). It is possible that young adults' superior performance is compromised when numerous lists increase interference effects.

Alternatively, the results from item analyses indicate that the magnitude of age differences can vary greatly from item to item (Kausler & Lichty, 1988). This suggests that discrepant findings across studies may be present because studies are not using the same SPT items. It is possible that the discrepancies across studies are a result of item selection. Age differences in SPT recall may be found only when lists are made up of numerous items which older adults recall as well as young adults. The contradictory findings in the literature may be understood when future studies identify those item characteristics which predict age differences in SPT recall, as discussed in Experiment 1.

Perhaps the most compelling explanation for the discrepant findings is list organization. In this study, recall of organized lists was significantly greater than recall of unorganized lists for older adults, whereas there was no organization effect for young adults. Age differences in SPT recall were eliminated when the list items were organized into four semantic categories and there were no objects present during encoding. Motor cues were not sufficient to eliminate age differences in the recall of unorganized SPT lists. This suggests that the combination of organization and motor cues are important in eliminating age differences in SPT recall.

When organization cues were combined with object cues, age differences were also eliminated in the traditional verbal/verbal test condition. Previous studies have also found that age differences in guided verbal memory tasks are eliminated (Hultsch & Deutsch, 1981). Using the traditional verbal memory testing procedure, older adults are able to bring their level of recall up to that of young adults when the items are presented with rich contextual cues, such as organization and object cues.

In conclusion, the discrepant results in the literature concerning age differences in SPT recall do not appear to be due to the differential use of objects in SPT studies. Other factors such as procedural differences, item selection, or list organization may account for the contradictory findings. This study provided evidence that age differences in SPT recall may be predicted when list items are not organized. Further work is needed to understand other item characteristics that may affect the magnitude of age differences in SPT recall and the interactive effects of objects which may influence recall, especially the extent to which object cues may interact with other characteristics of SPT items.

Table 2-1

Mean (and Standard Deviations) for Number of Items Recalled

Group (64[a])**	
Young	Older
43.2 (6.1)	33.2 (8.1)
Condition (64[a])**	
Verbal/Motor	Verbal/Verbal
41.8 (7.9)	34.6 (8.1)
Object Cue (32[a])*	
Objects	No Objects
19.8 (4.5)	18.5 (4.9)
Organization (32[a])	
Organized	Unorganized
19.4 (4.5)	18.8 (4.9)

Note. [a] Maximum possible score.
*$p < .001$. **$p < .0001$.

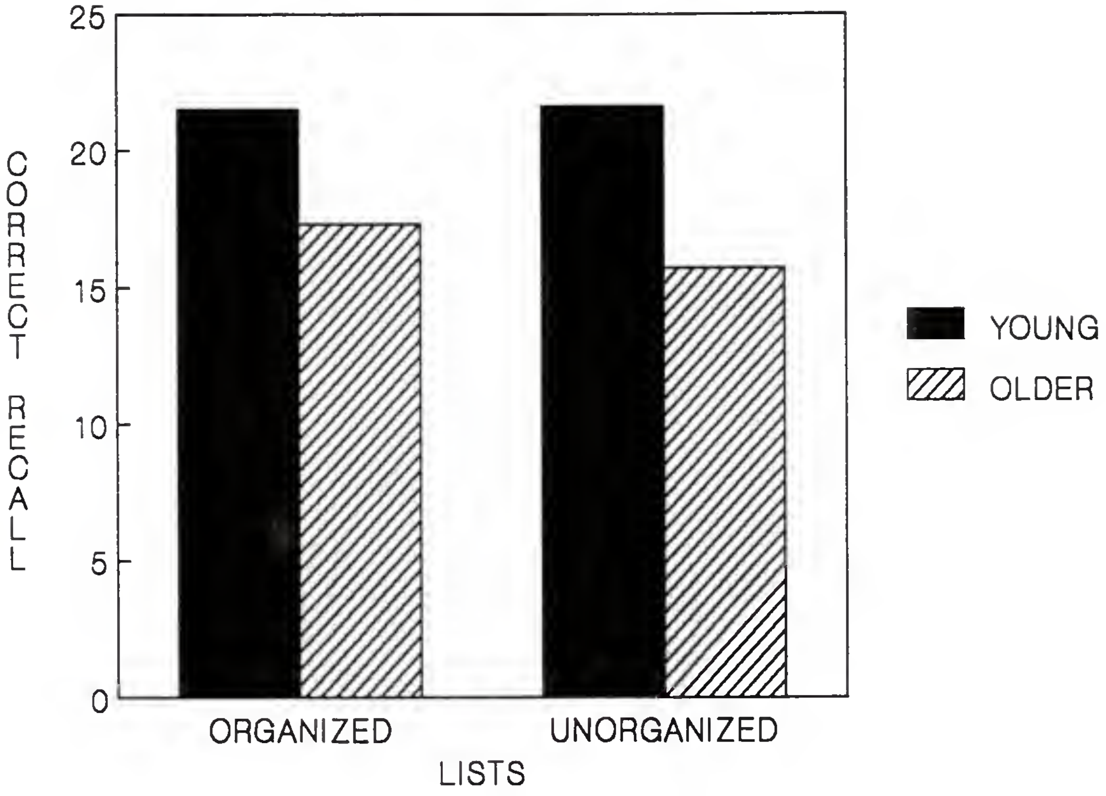

Figure 2-1: Recall by Age and Organization (Exp 2)

EXPERIMENT 3

Introduction

The magnitude of age differences appears to vary greatly from item to item in activity recall (Kausler & Lichty, 1988). The results of Experiment 1 also suggest that there may be important item characteristics which predict the magnitude of age differences in SPT recall. Some of these important item characteristics may be identified by comparing different activity measures. Various types of measures have been used in the literature on activity memory and aging. The most commonly used tasks are Subject Performed Tasks (SPTs) and cognitive activity tasks. SPT studies have often shown that age differences in recall are eliminated (Backman, 1985; Backman & Nilsson, 1984, 1985; G. Cohen & Faulkner, 1989; Dick & Kean, 1989). Using an alternative methodology, Kausler and his colleagues have investigated age differences in cognitive activities. They have used a variety of cognitive tasks including perceptual-motor, verbal learning, semantic memory, and problem-solving tasks. Their results have consistently shown that recall of cognitive activities is age-sensitive (Kausler & Hakami, 1983; Kausler, Lichty, & Davis, 1985; Kausler, Lichty, & Freund, 1985; Kausler et al., 1986; Kausler & Phillips, 1989; Lichty et al., 1986). This differential outcome has occurred in spite of many similarities between the two task types (Kausler & Lichty, 1988).

The first obvious distinction between the SPT and cognitive activity studies concerns differences in the type of item or task employed. There are two important distinctions between SPT and cognitive items. In contrast to SPTs, there are minimal motor cues in cognitive activities tasks, such as solving anagrams or answering questions of factual knowledge. A few cognitive activity tasks provide motor cues, such as object assembly and card sorting, but these are not typical. It is possible that the discrepant results from the SPT and the cognitive activity memory studies occur because SPT actions provide older adults with motor cues that they would not otherwise spontaneously generate.

While motor cues are an important distinction between SPTs and cognitive activities, the results of Experiments 1 and 2 suggest that motor cues during SPT encoding do not necessarily predict an elimination of age differences in recall. It is also possible that older adults are more proficient at recalling SPT items than cognitive activity items because SPT recall has fewer cognitive demands. In the Kausler studies, subjects were required to recall a task label or description of the cognitive activities, for example, "incomplete words" or "word-picture matching". In contrast, when a person recalls an SPT, they recall the specific action phrase that defined the act they performed, for example, "clap your hands" or "stretch your legs". Thus, recall of cognitive activities generally requires the subject to translate the actions into an unfamiliar label or description. No such transformation is required in SPT recall because the task labels are highly familiar phrases. When to-be-remembered items need to be transformed, young adults generally perform better (Craik, 1986).

In addition to the different items or tasks, the SPT and cognitive activity memory studies also have other important procedural differences which may account for the discrepant results. In the SPT literature, items have been presented at 5-8 second intervals. In contrast, the cognitive activity memory studies have had subjects perform activities for intervals of 45-180 seconds. Activity duration ranging from 45 to 180 seconds did not influence recall (Kausler et al., 1986). In addition, age differences in recall were found with presentation rates as long as 13 seconds (Knopf & Neidhardt, 1989). However, these studies did not examine presentation periods as brief as those used in SPT studies. It is possible that the very brief presentation rate of SPTs prohibits elaborate processing which would otherwise benefit young adults. The long presentation periods used in cognitive activity studies may provide young adults with ample opportunity to elaborately process the information to-be-remembered. An increase in the magnitude of the age-related recall deficit with longer presentation periods has been attributed to young adults benefitting from the additional time needed to carry out effective processing operations (Craik & Rabinowitz, 1985; Simon, 1979). Thus, presentation differences could account for the fact that investigators using short presentation times with SPTs have not found age differences in activity memory (e.g., Backman & Nilsson, 1984), whereas those using longer intervals with cognitive activities have found an age deficit in recall for activities (e.g. Kausler & Hakami, 1983).

Another possible explanation for the discrepant results concerns the differential use of objects. The SPT studies have typically used lists in which some items required the use of objects (e.g. "smell the soap" requires the use of soap), and some items did not involve objects (e.g. "yawn"). In contrast, the cognitive activity memory studies have not made as much use of external objects. It is possible that age differences are eliminated in SPT studies, but not in cognitive activity memory studies because older adults benefit more than young adults from the visual cues provided by the presence of objects. Some young adult studies have found no differences in recall of items with objects and items without objects (R. L. Cohen, 1988; R. L. Cohen, Peterson, & Mantini-Atkinson, 1987, Experiment 1). Others have found that the presence of objects sometimes facilitates recall (Helstrup, 1986, 1987) and sometimes impairs recall (R. L. Cohen, Peterson, & Mantini-Atkinson, 1987, Experiment 2). However, this earlier data did not address the question of whether the presence of objects are important in eliminating age differences in SPT recall. The results of Experiment 2 suggest that objects are not important in eliminating age differences in SPT recall. However, it was found that the presence of objects interacted with other variables such as motor and organization cues. Therefore, it was considered worthwhile to manipulate objects again in order to determine its role in the discrepant results in the activity literature.

The purpose of this investigation was to address the inconsistent findings concerning adult age differences in activity memory. It was first hypothesized that age differences in recall of cognitive activity tasks would be greater than age differences in the recall of SPTs (Backman & Nilsson, 1984, 1985; Dick & Kean, 1989; Kausler & Hakami, 1983; Kausler et al., 1986). It was also hypothesized that age differences in recall would be greater under slow presentation rate conditions than fast presentation rate conditions because the fast presentation period does not provide the additional time needed for young adults to elaborately process the items (Craik & Rabinowitz, 1985; Simon, 1979). Finally, it was expected that the discrepant findings from the SPT and cognitive activity memory studies may be accounted for by the differential use of objects in these studies.

Older adults are thought to benefit more from the object cues than young adults because older adults must rely on task-provided cues to enhance recall, such as the presence of objects (Backman & Nilsson, 1984, 1985). It was hypothesized that age differences in recall would be greater for items without objects than items with objects.

Method

Subjects

The subjects included 80 older adults (60-79 years, M = 68.7, SD = 4.9) and 80 young adults (18-26 years, M = 19.7, SD = 1.4). The older adults were recruited from the community by newspaper advertisement and solicitation at community organizations and senior citizen organizations and received $10.00 for their participation. The young adults were recruited from university classes and received course credit for their participation. The older and young adults did not differ in terms of educational background, $p > .06$ (older adult range = 8-21 years, M = 14.3, SD = 3.4; young adult range = 12-17, M = 13.5, SD = 1.0), or in their scores obtained on the WAIS Information subtest, $p > .09$ (older adult range = 8-18, M = 12.1, SD = 2.3, young adult range 6-17, M = 11.5, SD = 2.4). The older adults were screened for current health status to eliminate persons with cardiovascular disease or other chronic health problems that may affect memory performance.

Materials

Test items are listed in Appendix E. The SPT items were obtained from R. L. Cohen's (1981) SPT list. Examples of SPT items include "Toss the coin" and "Draw a stickman in the air". The cognitive items were obtained from Kausler et al. (1986). Examples of cognitive items include: "Name the misspelled words" and "Solve these problems". The SPT items used in the fast presentation did not vary from those commonly used in the SPT literature (Backman & Nilsson, 1984; 1985; R. L. Cohen, 1981). Subjects repeated each action for 8 seconds. The same SPT items were lengthened for the slow presentation by repeating the action until the 45 second interval passed. For example, subjects repeatedly tossed a coin for 45 seconds. The cognitive items used in the slow presentation did not vary from those used in the literature (Kausler et al., 1986; Kausler & Hakami, 1983). The same cognitive items were also presented by reducing the length of the activity.

For example, only four cards were used in the 8-second version of the Card Sorting activity, as opposed to 60 cards for the 45-second version.

Procedure

All subjects were given one sixteen-item list which was made up of eight SPT items and eight cognitive activity items. Order of items was counterbalanced such that half of the subjects received the SPT items first followed by the cognitive items and the other half received the reverse order. Subjects were randomly split such that half of the subjects received an 8-second presentation period and the remaining half of the subjects received a 45-second presentation period. The presence of objects in the list was determined randomly with the constraint that half of the SPT items used objects and half of the cognitive items used objects.

Following test instructions (see Appendix F), a practice task using both SPT and cognitive activity items was demonstrated to the subjects. Participants were shown a 3 x 5 card with an activity description written on the card. For example, all subjects received a card that read "Draw a stickman in the air", or "Solve these problems". For some cognitive items, such as "Solve these problems", the experimenter provided additional instruction (i.e. "How much is four dollars plus five dollars?"). Subjects were instructed that they were to remember only the information written on the cards. With the card still in view, the subjects performed the described activities for either 8 or 45 seconds, as instructed. For those items which required objects, the object was handed to the subjects as the item was read. The object was in view for the full presentation period. No distractor objects were used. After the presentation period expired, the card and object were removed and the subjects were instructed to stop the action. After all items had been presented, written free verbal recall of the task label that appeared on the card was required. Responses were given full credit for an accurate description or paraphrase of the task label. Inter-rater reliability based on two examiners scores produced a correlation of .97.

Results

The analysis was a 2 x 2 x 2 x 2 mixed factorial in which the item type and use of objects were within-subject factors and rate of presentation and age group were between-subject factors. An initial analysis including order effects showed no significant main effects or interactions, so order was not included in the analyses reported here. All apriori comparisons were conducted with Tukey's test ($p < .05$). There were significant main effects for age group, $F(1,156) = 93.67$, $p < .001$, $w^2 = .35$; item type, $F(1,156) = 52.8$, $p < .001$, $w^2 = .23$; object, $F(1,156) = 29.28$, $p < .001$, $w^2 = .15$; and rate, $F(1,156) = 17.33$, $p < .001$, $w^2 = .06$ (see Table 3-1). Young adults recalled more than older adults. SPTs were recalled at a higher rate than cognitive activities. Items without objects were recalled at a higher rate than items with objects. Finally, more items were recalled at a slow rate of presentation than a fast rate.

Several interactions qualified these main effects. The item type by age interaction was significant, $F(1,156) = 5.87$, $p < .05$, $w^2 = .01$. SPTs were significantly easier for older adults to recall than cognitive activities but there was no item effect for young adults (see Figure 3-1). This item effect is at least a partial explanation for why age differences have been prominent in studies of cognitive activity recall (e.g., Kausler & Hakami, 1983), but not in studies of SPT recall (e.g., Backman, 1985).

The item type by rate, $\underline{F}(1,156) = 9.38$, $\underline{p} < .005$, $\underline{w}^2 = .01$; and the item type by object interactions were also significant, $\underline{F}(1,156) = 9.17$, $\underline{p} < .005$, $\underline{w}^2 = .03$; as well as the rate by item type by object interaction, $\underline{F}(1,156) = 6.03$, $\underline{p} < .05$), $\underline{w}^2 = .01$ (see Figure 3-2). The triple interaction is explained by the following: All conditions were the same among the cognitive items. Rate and the presence of objects had no effect. In contrast, there was a rate by object interaction among the SPT items such that the object effect was significant for the fast rate and not for the slow rate. The presence of objects led to reduced recall, especially in the fast condition in which the objects were presented so rapidly that they may have played the role of a distractor rather than the role of a facilitative cue.

Finally, there was a significant age by rate by item type by object interaction, $\underline{F}(1,156) = 6.27$, $\underline{p} < .05$, $\underline{w}^2 = .02$ which superseded the other effects (see Table 3-2). This interaction is explained by the following: There were significant age differences on the recall of cognitive items in all conditions. For the SPT items there were significant age differences only in some conditions (see Figure 3-3). This interaction was due to the combined effects of speed of processing and the presence of objects, as discussed below.

A 2 (age) x 2 (rate) analysis of variance using ARC scores was conducted in order to investigate the role of organization on recall. The effects of organization as a function of item type and presence of objects were examined by obtaining two ARC scores, one based on clustering by item type and a second based on clustering according to the presence or absence of objects. It has been argued that age differences in activity recall are eliminated because activity recall does not rely on strategies such as organization (Backman & Nilsson, 1984; R. L. Cohen, 1984). However, the results of Experiments 1 and 2 suggest that list organization is an important predictor of age differences in SPT recall. In this analysis, both ARC scores produced nonsignificant main effects for age and presentation rate and nonsignificant interactions. This suggests that the observed effects here were not related to clustering differences across conditions. However, as was found in Experiment 1 and 2, large standard deviations restrict the interpretation of this data.

Discussion

There were significant age differences in recall of SPTs and cognitive activities, although the age difference was substantially greater for the cognitive activities than the SPT items. The age by item type interaction indicated that older adults performed significantly worse on cognitive activity memory tasks than on SPT recall tasks, whereas young adults performed at the same level on both tasks. Several explanations have been offered for these discrepant findings. These will be discussed in turn.

It was suggested that age differences in SPT recall may be smaller because the faster presentation rates used in previous SPT studies may not have provided the additional time needed for young adults to elaborately process the items. These data have not confirmed this hypothesis because age differences in recall of the two item types were significantly different even when presentation rate was matched. Also, in this study, recall was greater with the slower presentation rate, more typical of the cognitive activity paradigm. The additional processing time aided recall for both age groups. Based on these results, the age deficit which is found in the cognitive activity literature, but not in SPT studies, can not be explained by the presentation rate differences in the literature.

It was also suggested that age differences may be eliminated in SPT recall because there are typically more object cues used for SPTs than cognitive activities. This was also not confirmed because recall was greater for the items that did not use objects.

This indicates that the elimination of age differences in SPT memory can not be attributed to the provision of objects during SPT _encoding_. Cohen and his colleagues also found that items without objects yielded better recall than those with objects (R. L. Cohen, Peterson, & Mantini-Atkinson, 1987). They argued that this difference may be explained by cuing differences during _retrieval_. Unlike items that use body parts, items that used objects at encoding did not have the objects available during retrieval. Items without objects at encoding could be recalled at a higher rate because those items provide environmental cues during retrieval such as one's hands in the item "clap your hands" or one's legs in the item "stretch your legs". This is consistent with Kausler's notion that recall of activities may be enhanced by ecphoric processing of contextual information at retrieval (Kausler & Lichty, 1988). Age differences in SPT recall have been observed when no environmental cues were available at retrieval (Knopf & Neidhardt, 1989).

In addition to the retrieval explanation, it is also possible that the presence of objects during encoding decreased recall because there was simply more information to process: the object, the action itself, and the to-be-remembered phrase on the card required attention. It is possible that the presence of the objects distracted participants away from processing the verbal content of the to-be-remembered phrase (see Backman, Nilsson, & Chalom, 1986). The processing of additional information may have reduced recall particularly for older adults (see the discussion of the age interaction below).

The final explanation, item type, remains the most compelling distinction between SPT and cognitive items. As previously suggested, SPTs involve motor cues that are not typically available for cognitive activities. However, the results of Experiments 1 and 2 suggest that motor encoding may not be the most important determinant of age differences in activity recall. Alternatively, the recall of cognitive activities may place greater demands on memory because the task labels for the cognitive items generally require the subject to translate the action into a label, whereas no such transformation is required for SPTs. During SPT learning, individuals attend to items such as "raise your arm" and carry out this action. Later, they recall "raise your arm". In contrast, the cognitive activity, "solve these problems", directs attention to arithmetic word problems and asks for solutions. At recall, persons must remember "solve these problems", not the specific instructions they heard, e.g., "how much is four dollars plus five dollars?". When the to-be-remembered information requires the subject to translate or transform that information for recall, older adults are at a greater disadvantage (Craik, 1986; Kausler & Lichty, 1988). Parenthetically, this argument was supported by the common observation from participants that items which required them to "think" (e.g., naming animals) actually distracted them from what they needed to recall.

More studies with varying item types and varying the form of the to-be-remembered phrase would help test these notions. It is clear that what we are distinguishing as "SPTs" and "cognitive activities" lie on a continuum of to-be-remembered actions, ranging from simple everyday body movements to complex tasks from intelligence tests. These results point out that we need to be careful about identifying and maintaining experimental control over item characteristics that could affect the pattern of age differences, just as in the verbal memory literature, control has been maintained traditionally over variables such as word frequency and concreteness. Item differences in the percentage of persons who can recall specific activities ranges from 33% to 100% (Kausler & Lichty, 1988). This suggests that item characteristics, as yet undetermined, could predict activity recall.

One attempt to explain interitem recall differences in terms of differences in item familiarity, vividness, and the availability of environmental cues was unsuccessful (R. L. Cohen, Peterson, & Mantini-Atkinson, 1987). Also, familiarity, per se, does not appear to explain the observed aging pattern in SPT research (Knopf & Neidhardt, 1989). In addition, previous research has also investigated list characteristics such as organization (Backman & Nilsson, 1984, 1985; Norris & West, 1988). This study found no age differences in organization, however, large standard deviations limit the interpretation of this data. Further research in this area may shed light on those item characteristics and stimulus properties which enhance the memory performance of older adults.

These results, for instance, point to the importance of item type, rate of presentation and presence of objects as factors that interact to affect age differences. Age differences were present in recall of cognitive items in all conditions. Older adults performed poorly in cognitive activity recall and manipulations of the presentation rate and the presence of objects do not reduce this age deficit. In contrast, such manipulations did vary the age differences in SPT recall. First, age differences in SPT recall were present in the fast condition with objects. Comparisons showed that older adults recalled significantly fewer items in the fast condition with objects than in the remaining three conditions. It is likely, then, that the presence of the objects required additional information to be processed and the fast presentation rate allowed very little time, making this the most difficult SPT condition for older adults. Hence, when older adults were faced with more information to process in a small amount of time, they performed significantly worse than young adults (see Figure 3-3).

At the same time, age differences in SPT recall were also present in the slow condition without objects. Comparisons indicated that the young adults recalled significantly more items in the slow condition without objects than in the remaining three conditions.

Thus, the slow condition without objects provided ample processing time for young subjects to spontaneously apply strategic knowledge to the task at encoding and to possibly think about potential environmental cues, such as one's arm, to use at retrieval. In contrast, older adults' recall was the same in the slow condition (regardless of the presence of objects) suggesting that even when given the time, they do not engage in this cuing strategy during retrieval. It has been argued in the literature that longer encoding times are beneficial to young adults because this gives them the additional time needed to carry out effective processing operations (Craik & Rabinowitz, 1985). Our results confirm that when young adults have less information to process and more time in which to do so, they used their time effectively to aid subsequent recall.

The results of this investigation suggest that age differences in SPT recall may not be predicted on the basis of rate of presentation alone. Rather, the magnitude of age differences may depend on the time available to process the information and the combination of the amount of information to be processed. Thus, when the older adults had either less information to process (that is, no objects were present) or more time to process object cues, they were able to bring their recall up to the level of young adults. It has been argued that age deficits in recall are due to older adults being less likely than young adults to encode contextual information (Kausler & Lichty, 1988). Older adults' recall was enhanced when they were provided with additional retrieval cues in the environment and the time necessary to process the information.

This study clearly indicated that the magnitude of age differences in activity recall varies as a function of item type. The discrepant findings from the SPT literature and the cognitive activity literature can not be attributed to the differential use of objects or to presentation rate effects because age differences were found even when presentation rate and object cue were matched. Rather, the items or tasks themselves appear to account for the discrepant results. Item characteristics such as the form of the to-be-remembered information and item distinctiveness are worthy of further exploration.

Table 3-1

Means (and Standard Deviations) for Number of Items Recalled

Group (16^{a})	
Younger	*Older*
10.7 (2.5)	7.2 (2.3)
Item Type (8^{a})	
SPTs	*Cognitive*
5.0 (1.8)	3.9 (1.9)
Object Cues (8^{a})	
No Objects	*Objects*
4.8 (1.7)	4.1 (1.8)
Rate (16^{a})	
Slow	*Fast*
9.7 (2.9)	8.2 (2.8)

Note. ^{a}Maximum possible score
For each main effect, differences were significant at $p < .001$.

Table 3-2

Mean Number of Items Recalled as a Function of Age, Item Type, Objects, and Rate

SPTs

	Objects		No Objects	
Group	Fast	Slow	Fast	Slow
Younger	2.3_b	2.8_b	2.8_b	3.6_c
Older	1.4_a	2.3_b	2.3_b	2.6_b

Cognitive Activities

	Objects		No Objects	
Group	Fast	Slow	Fast	Slow
Younger	2.3_b	2.4_b	2.4_b	2.8_b
Older	1.5_a	1.2_a	1.3_a	1.7_a

Note. Means with different subscripts within each item type differ significantly at $p < .05$.

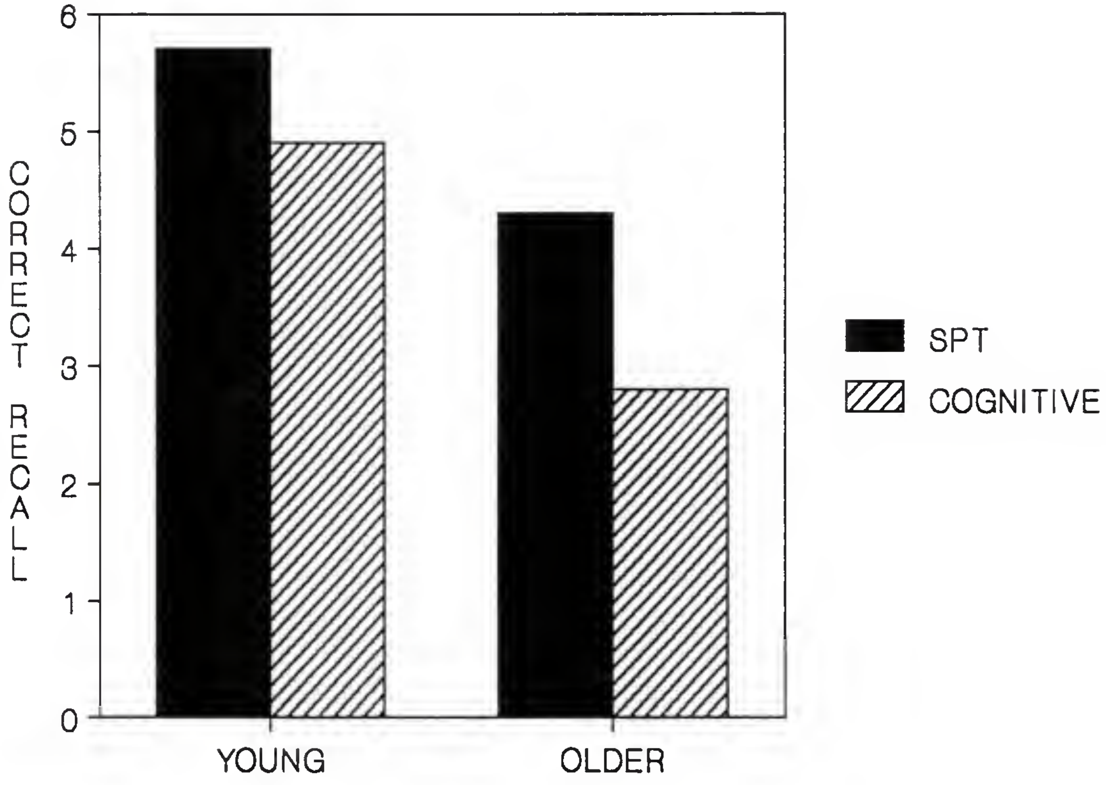

Figure 3-1: Recall by Age and Item Type

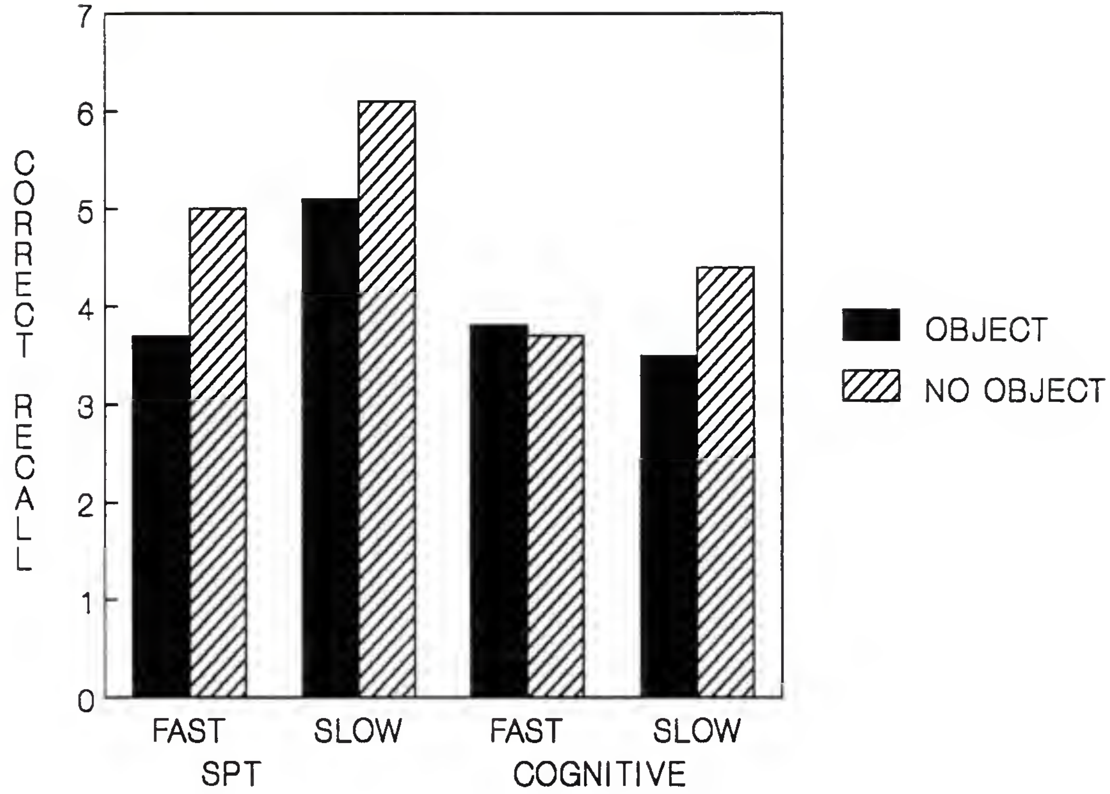

Figure 3-2: Recall by Rate, Item Type and Object

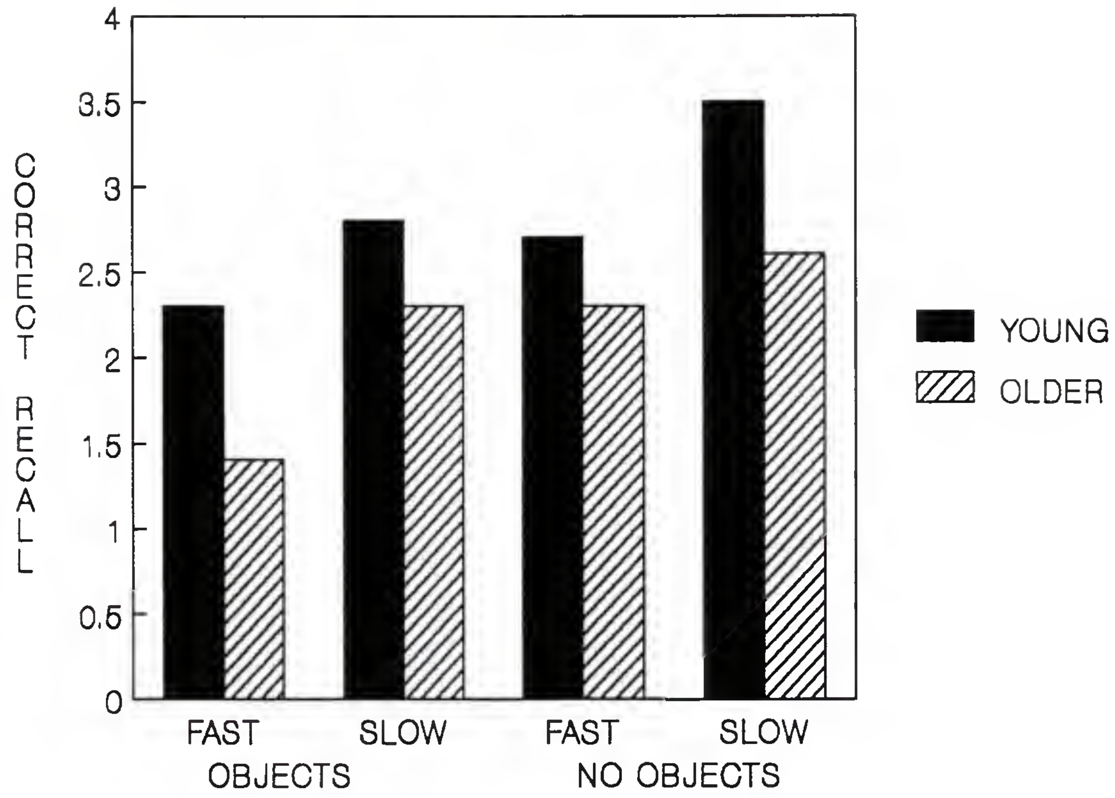

Figure 3-3: Interactive Effects in SPT Recall

GENERAL DISCUSSION

The results of these experiments provided evidence that SPTs are a different class of events than traditional verbal tasks. These differences are important in understanding older adults' improved memory performance on SPT recall. First, unlike verbal recall tasks, SPT recall is not influenced by serial position. Previous SPT literature has determined that SPT recall is not dependent on rehearsal; however, this had not been examined as a function of age. The results of this investigation showed that both young and older adults do not rehearse early list items. This substantiates the notion that the lack of age differences in SPT recall is at least partially accounted for by the nonstrategic nature of SPT processing, at least with regard to rehearsal.

The serial position analysis also suggested that there are important item characteristics which make some SPT items more distinctive than others. Some items had greater recall probability regardless of their position on the list. Recall of motorically processed information appears to be predicted on the basis of item distinctiveness, not list position. In contrast to verbal recall tasks which are greatly influenced by serial position, the magnitude of age differences in SPT recall appears to be item-dependent. Finally, verbal and SPT recall tasks appear to be fundamentally different in terms of those stimulus properties which predict recall. The relevant stimulus properties for word recall and SPT recall are not the same. For example, familiarity and concreteness predict word recall, but not SPT recall (Knopf & Neidhardt, 1989). Further research is needed to identify those item characteristics which predict SPT recall.

The results of these investigations lend support to the notion that retrieval mechanisms in SPT recall should be emphasized. The elimination of age differences in SPT recall has been attributed to the encoding of the multimodal properties of SPTs (Backman & Nilsson, 1984, 1985); however, this notion was not supported by these investigations. The combination of motor and object cues during encoding did not eliminate age differences in recall. Other experiments have also found age differences under these conditions (R. L. Cohen, Sandler, & Schroeder, 1987; Guttentag &

Hunt, 1988; Knopf & Neidhardt, 1989; Craik, 1989; Nilsson & Backman, 1989).

The presence of objects during encoding did not influence age differences in recall; however, object cues interacted with other variables to influence recall. The presence of objects improved recall in the absence of other cues such as motor encoding and list organization, but had no effect on recall when these other cues were present. Perhaps object cues did not effect age differences in SPT recall because they are less powerful than other contextual cues. Furthermore, the presence of objects may also impair recall, as is suggested in the literature (R. L. Cohen, Peterson, & Mantini-Atkinson, 1987). The presence of objects reduced recall when the objects and information to-be-remembered were presented at a fast rate. This suggests that contextual cues may lose their beneficial effect when there is not adequate time for processing the additional information.

While the results of this investigation has not supported the notion that multimodal sensory cues during encoding are effective in eliminating age differences, other important contextual cues appear to foster older adults' performance in SPT recall. There was no age-related memory deficit in SPT recall when motor cues were provided during retrieval. This supports Kausler and Lichty's (1988) notion that ecphoric processing is important in eliminating age differences in recall. That is, older adults improve their level of recall when contextual cues during retrieval correspond to the information which was processed during encoding so that this information is readily elicited at retrieval.

In addition to motor retrieval cues, list organization was found to be an important predictor of the magnitude of age differences in SPT recall. There was support for the notion that the multidimensional task properties of SPTs enhance the detection of superordinate categories for older adults. Older adults used organization strategies when information was motorically processed to bring their level of recall up to that of young adults.

While organization has typically been viewed as an encoding strategy according to the information processing model, it is possible that organization aids recall also because of its influence during retrieval (Burke & Light, 1981). Items recalled from a particular category may cue recall during retrieval for other items belonging to that category.

The importance of item characteristics has also been demonstrated in these experiments. The magnitude of age differences varied a great deal across SPT items. Little is yet understood about what item characteristics predict SPT recall. Several characteristics can be considered. First, older adults were more adept at recalling items with fewer cognitive demands. This suggests that simplicity may in some way be predictive of age differences in activity recall. Older adults' poor recall of complex mental activities is consistent and impervious to manipulations such as rate of presentation or object cues. Second, item distinctiveness may also be important in predicting recall probability because of its value during retrieval. Kausler and his colleagues have argued that the retrievability of memory traces varies directly with the distinctiveness of those traces. Further research is needed to identify the stimulus properties which make items highly distinctive for older adults. Finally, it is also possible item recall depends, in part, on the specific information to-be-remembered. Young adults may be at an advantage when activities must be translated into an unfamiliar label or description. Familiarity of task label may also be important in terms of its influence during retrieval. Older adults may be penalized when the information to-be-remembered is not readily accessible during retrieval because of the need to transform the action performed into an unfamiliar label.

While the importance of retrieval cues in eliminating the age-related memory deficit is suggested from motor retrieval cues, organization cues, item distinctiveness, and task label, there is also evidence that encoding operations influence age differences in SPT recall. First, the absence of rehearsal during SPT encoding reduces the age deficit in recall. In addition, the magnitude of age differences in SPT recall depends on the combination of the amount of information to be processed and the time available to process the information. Older adults are able to bring their level of recall up to that of young adults when there is ample time to process the amount of information presented during encoding. Additional information such as object cues which are meant to facilitate recall may, in fact, reduce recall when there is little time for processing the information.

This indicates that processing demands during encoding can impair recall for older adults.

As predicted by the processing and contextual models of memory and aging, the results of these investigations reiterate the notion that older adults rely on cues and strategies which are generated by the examiner or test conditions (Winocur, 1982). Age differences in SPT recall are eliminated when older adults do not have to generate the cues for themselves. The specific cues and strategies which are important in eliminating age differences is debated in the literature (Perlmutter, 1978). Guided processing during encoding in combination with retrieval support has resulted in an elimination of age differences in recall (Craik, 1977; Perlmutter & Mitchell, 1982). These experiments provide further support for the notion that encoding cues alone are not sufficient to significantly improve older adults' recall. When retrieval cues are provided, whether in the form of motor processing, highly distinctive items which create a stable memory trace, or cues from recall of categories, the contextual information which was processsed at encoding is reinstated and recall improves.

APPENDIX A

HEALTH INTERVIEW

1) Have you had any hospitalizations or major illnesses in the last five years?

2) Do you have any medical conditions which you are currently seeing a physician for?

3) Are you taking any medications now? If so, what are the medications and what are they prescribed for?

4) Do you have any history of cardiovascular disease, strokes, heart attacks, or high blood pressure?

5) Are you aware of any history of Alzheimer's disease in your family?

6) Do you have significant hearing or vision loss?

APPENDIX B

LIST OF SPT ITEMS

Organized List

Snap your fingers

Cross your legs

Blow in the air

Stretch your legs

*Lean to the left

*Tap your foot

Stick out your tongue

Tilt back in your chair

Clasp your hands together

*Bend forward at the waist

*Raise one leg

Count the fingers on one hand

Laugh

Shrug your shoulders

Cross your fingers

Yawn

Note. * Indicates item has been added by investigator.

Unorganized List

Shake your head back and forth
Pretend to be asleep
Name the street you live on
Knock on the table
Clap your hands
Cup your hand over your ear
Draw a stickman in the air
Point to your mouth
Pretend to play the piano
Nudge the arm of the chair
Clear your throat
Scratch your nose
Smooth your hair
Blink three times
Flex your arm
Wave good-bye

APPENDIX C

TEST INSTRUCTIONS

Verbal Encoding/Verbal Retreival

A list of actions such as, "Point to the door" will be read to you. Your task is to listen carefully to the items and to try to remember them. After I have read the list you will be asked to write down as many items as you can remember in any order, but exactly as I read them to you. There will be five lists all together. At the beginning of each list we will do some practice items so I can see if you have any questions about the task. Remember, you will not actually do what the items say. You are only to try to remember them.

Verbal Encoding/Motor Retrieval

A list of actions such as, "Point to the door" will be read to you. Your task is to listen carefully to the items and to try to remember them. After I have read the list you will be asked to actually perform as many of the actions as you can remember in any order, but exactly as I read them to you. There will be five lists all together. At the beginning of each list we will do some practice items so I can see if you have any questions about the task. Remember, first you are to listen to the items. After the entire list has been read to you, then you will perform the actions.

Motor Encoding/Verbal Retrieval

A list of actions such as, "Point to the door" will be read to you. Your task is to perform the actions as I read them and to try to remember them. After I have read the list and you have performed all the actions, you will be asked to write down as many of them as you can remember in any order, but exactly as I read them to you. There will be five lists all together. At the beginning of each list we will do some practice items so I can see if you have any questions about the task. Remember, first you will perform the actions as I read them. Then, you will write down as many as you can remember after you have heard the whole list.

Motor Encoding/Motor Retrieval

A list of actions such as, "Point to the door" will be read to you. Your task is to perform the actions as I read them and to try to remember them. After I have read the list and you have performed all the actions, you will be asked to again perform as many of them as you can remember in any order, but exactly as they were done before. There will be five lists all together. At the beginning of each list we will do some practice items so I can see if you have any questions about the task. Remember, you will perform the actions as I read the list. After you have heard the whole list, you will again perform as many of them as you can recall.

APPENDIX D

SPT ITEM LIST

Organized List Without Objects

Snap your fingers

Cross your legs

Blow in the air

*Lean to the left

*Tap your foot

*Stick out your tongue

*Tilt back in your chair

*Clasp your hands together

*Bend forward at the waist

*Raise one leg

Count the fingers on one hand

Laugh

Stretch your legs

Shrug your shoulders

Cross your fingers

Yawn

Organized List With Objects

*Open the sewing kit

Stretch the rubber band

*Tear off a piece of dental floss

*Name the spice

*Open the toothpaste

Fasten the safety pin

Lift the stapler

*Tell me how much the measuring cup holds

Put the cap on the pen

*Pretend to cut with the knife

*Pick up the razor

Unzip the zipper

*Pretend to use the can opener

Put on the thimble

Sharpen the pencil

*Smell the soap

Unorganized List Without Objects

Shake your head back and forth

Pretend to be asleep

Name the street you live on

Knock on the table

Clap your hands

Cup your hand over your ear

Draw a stickman in the air

Point to your mouth

Pretend to play the piano

Nudge the arm of the chair

Clear your throat

Scratch your nose

Smooth your hair

Blink three times

Flex your arm

Wave good-bye

Unorganized List With Objects

Say what time is on the watch

Look in the mirror

Close the purse

Throw the dice

Stack the checkers

Push the toy car

Bounce the ball

*Spin the top

Put on the ring

Cut the cards

Roll the marble

Cut the piece of paper

Pick up the chalk

*Name the color of the crayon

Open the book

Pretend to blow the horn

Note. * Indicates item has been added by the investigator.

APPENDIX E

COGNITIVE AND SPT ITEM LIST

Slow Presentation Rate

Learn these words (house, tree, paper, dog, shoe, bicycle, red, big)

Cancel out all the A's on the page

Sort these cards by odd and even

Say if the word matches the picture

Name the misspelled words

Name fifteen animals

Answer These Questions: ("What are the colors in the American flag?", "What is the shape of a ball?", "How many months are there in a year?", "What is a thermometer?", "What is the capital of Florida?", "How many legs does a dog have?", "Who was the first president of the United States?")

Solve These Problems: ("How much is four dollars plus five dollars?", "If you have 3 books and give 1 away, how many do you have left?", "If you buy six dollars worth of gasoline and pay for it with a ten dollar bill, how much change should you get back?", "Raffle tickets cost 25 cents each. How much would it cost to buy six tickets?")

Raise your arm

Put the matches in the box

Toss the coin

Draw a stickman in the air

Measure these boards

Salute

Tie ten knots

Look up at the ceiling

Fast Presentation Rate

Learn these words (house, tree)

Cancel out all the A's on the page

Sort these cards by odd and even

Say if the word matches the picture

Name the misspelled words

Name four animals

Answer This Question: ("What are the colors in the American flag?")

Solve This Problem: ("How much is four dollars plus five dollars?")

Raise your arm

Put the matches in the box

Toss the coin

Draw a stickman in the air

Measure this board

Salute

Tie a knot

Look up at the ceiling

Note. Instructions written in parentheses were read to the subjects and were not part of the required recall. Also, first eight items in list are cognitive activity items and the last eight items in the list are SPT items.

APPENDIX F

TEST INSTRUCTIONS

Slow Rate of Presentation

For the next list there will be some changes. You will read the list items from cards, and you will perform each item for a period of forty-five seconds. I will tell you when to stop. After you have performed all of the items on the list you will be asked to write down as many of the items as you can remember. You are to write down exactly what was written on the cards. We will do some practice items first. Do you have any questions?

Fast Rate of Presentation

For the next list there will be some changes. You will read the list items from cards, and you will perform each activity for a period of eight seconds. I will tell you when to stop. After you have performed all of the items on the list you will be asked to write down as many of the items as you can remember. You are to write down exactly what was written on the cards. We will do some practice items first. Do you have any questions?

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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